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AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

EDITED BY

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ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

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Preface.

IN completing our first volume of the New Series of THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE, we feel justified in saying that considerable advance has been made in interest and usefulness, both as regards the subject-matter of the papers published and of the explanatory plates accompanying them.

Many of our readers have already given us their good opinions, and doubtless many others who have not actually so expressed themselves will credit us with having redeemed the promises we made twelve months ago. Our desire is to keep on improving the Journal by admitting into its pages only such papers as shall be of substantial worth to workers in science, and such items of scientific interest as shall be worth registering for future reference.

To those writers who have favoured us with such papers our especial thanks are due, and we best acknowledge our

obligations to them by assuring them of our earnest desire to further improve the Journal and render it more worthy of their contributions.

Our readers who have enabled us to carry out these improvements by their subscriptions and recommendations are also thanked for their kindness, which has enabled us to realise our plans and justified our resolution to still further advance the usefulness of the Journal. These improvements must involve considerable outlay; but in full reliance upon the promises of increased support, we unhesitatingly undertake the additional labour and expense.

Experience in the past will enable our readers to appreciate the value of our promises for the future.

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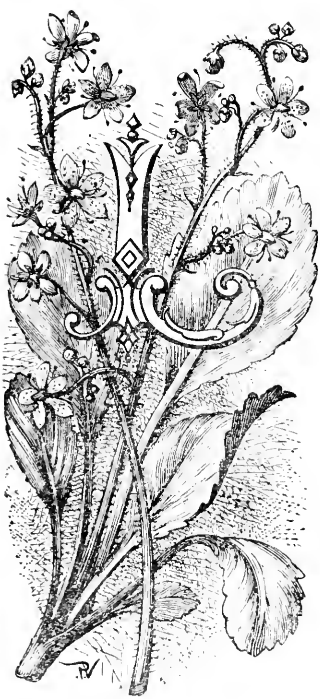
"*Knowledge is not given us to keep, but to impart: its worth is lost in concealment.*"

Presidential Address.

By the Hon. J. G. P. Vereker, September 8th, 1887.



LADIES AND GENTLEMEN,—

Allow me to thank you very much for the honour you have done me in electing me as President of the Postal Microscopical Society for this year. I feel great diffidence in accepting this post, and must ask your kind indulgence for any shortcomings I may be guilty of.

I have for many years had the privilege of belonging to the Society, and have derived much pleasure and profit from it. I think we may now consider its position as firmly fixed, and that if we go on as we have begun we shall always hold a good place among the scientific societies of England.

Our Journal has done a good deal for us in this direction, and whenever I look into it I feel

proud to be a member of a Society which issues a periodical so good in both text and illustrations.

I am certain that you all agree with me how grateful we ought to be to our Secretary for the trouble and care he takes in its issue and in the welfare of the Society, and feel that it is our bounden duty to assist him in this task to the utmost of our ability. Perhaps one of the best ways of doing this would be to try and get more new members, which ought to be done pretty easily, as our subscription is very small, and we occupy a position with reference to microscopy which ought to be most serviceable and agreeable to many of us quiet students of nature. Our method of communication being by post, we are enabled to reach all parts of the kingdom with great facility, and thus being brought into direct communication with each other are able to mutually assist members both in theory and practice.

It seems superfluous to remind microscopists of the great charms of the study of the "infinitely little," but as there may be some present who have not engaged in that study, perhaps those familiar with microscope work will allow me briefly to summarise what are some of its great attractions. Microscopical work is one of those studies which can be pursued everywhere, for there is no place where objects for study may not be found, added to which it is quite independent of the weather or of the time of day, as artificial light can always be used, and in fact many microscopists seldom use any other.

Then it is a silent work, and disturbs no one, and requires but a small space for the apparatus. It also tends to develop habits of care and neatness, as the smallest speck of dirt shows most prominently under the lens, and without neatness it is impossible to keep the instrument in order, much more so to make any accurate observations. Again, the patient investigation required, the measuring and drawing of those objects under examination, create very careful habits of observation, which react on the observer and make him more careful in other matters.

Finally, the field of microscopical research is so large that all tastes may be satisfied. The exactness of forms of crystals, diatoms, etc., the different methods of strengthening cell-walls, and many other points, are of great interest to the mathematical

mind; the various modes of assimilation of food and reactions of substances used in microscopy interest the chemist; the marvellous adaptations of means to an end, and countless varieties of forms are of great interest to the scientist; the wonderful play of colour under the polariscope, the scales of butterflies, the great beauty of the forms of lower life, the varieties of small insects, and, if I may be permitted the word, their various expressions (I have never forgotten the expression of cruel ferocity of the head of a spider—a diamond spider, I think—sent round mounted dry and uncrushed in one of the boxes some years back), and many other points too numerous to mention, are a source of endless enjoyment to the artist; as for him of a speculative turn of mind, the curious metamorphoses and various developments of life, the strange world of microscopical life, the curious effects their microscopical eyes must give, with a thousand other points, enables him to imagine worlds more strange than any fairy tale, and to weave romances wilder, yet possible, than any of Jules Verne's works.

Yet all this while time is not being wasted, for knowledge is being increased and the mind is being strengthened. With advantages like these I have so cursorily glanced at, is it to be wondered at that microscopists very soon become enthusiasts in their work, for they find that the microscope has practically given them a new sense with all the delights attached thereto, and none of the disadvantages?

All this pleasure can now be obtained at a much lower price than was possible some years back. English opticians have also awakened to the fact that there are many inherent advantages in the short foreign tube of five or six inches, especially when the instrument has to be used upright, as it must be when there are liquids on the stage. Everyone is not a diatomist, and for many purposes low-angled lenses are as good as wide-angled ones, besides being more convenient in use, and of course cheaper. All this is an undoubted advantage to those who want a microscope for use and not for show.

If, however, the intending purchaser would take the advice of a competent friend and be more careful about getting good eyepieces, and also remember that a good low power is better than a bad high power—in fact, that good lenses are pleasanter in use,

really show more detail, and are not so trying to the eyes as bad ones often are—we might find more enthusiasts, and fewer of those who buy a microscope, and then get tired of its use. The members of the Postal Microscopical Society might do a great deal of good by popularising the use of the microscope, sweeping away the mystery which surrounds it, and save people from wasting their money in the purchase of inferior instruments.

We should probably thus increase the number of students and acquire new members, by infusing fresh blood into the Society, give it new life and a large addition of brain power. An important advance in practical optics has just been made which will probably have a great effect on microscopes—namely, the manufacture of a specially dense glass by Messrs. Schott and Co. This glass has already been utilised by the well-known opticians, Messrs. Zeiss and Co., in the manufacture of a special series of lenses known as the "apochromatic objectives," and experiments are now being carried on in England with the same glass. The great advantage claimed by its use is the abolition of the secondary spectrum which exists in lenses at present, and gives rise to the colour corrections of different opticians, the best of which is the well-known ruby correction, which I believe was introduced by Messrs. Powell and Lealand. A tertiary spectrum remains, but its colouring power is weak, so the images of objects are practically free from colour, and a nearer approach is made to achromatism. The images thus produced are clearer and sharper, and show their natural colouration better. The objectives themselves thus approach much nearer to their theoretical performances, and in consequence will bear much stronger eye-pieces.

This is, of course, a great improvement. We all know by experience the great nuisance of perpetually changing the objective in an investigation, an inconvenience which is not satisfactorily obviated by any form of nose-piece that I have ever seen. For instance, suppose a botanical section is being examined wanting powers of about 40, 100, and 200. Formerly a one-inch, a half-inch, and a quarter-inch were required for this. Now, with this new advance, one power of an inch and three eye-pieces will answer the purpose. I do not mean to say that high powers will no longer be required, but that now we will be able to suit the

aperture to the object better than formerly, and I am inclined to think that the one-tenth inch will be the highest required.

It is too early, however, to give any decided opinion on this subject, as often these matters do not come up to the general expectation. Besides this, the only lenses at present in the market are those of Messrs. Zeiss and Co.—at least, so I believe—and they are dear and not easily obtainable. I got a dry 1—6th inch from them just before leaving England, and during the short time I was able to use it, it seemed to be very satisfactory.

One result of this invention is that probably a very fair number of good second-hand lenses will come into the market and be sold cheaply. Those, however, who are thinking of buying a high-power lens, but are not in immediate need of it, would act wisely in waiting a short time to see if lenses made of this glass can be more easily procured. Messrs. Zeiss and Co. have produced a series of lenses under Professor Abbe's calculations of this new glass and a series of eye-pieces to go with them. Both objectives and eye-pieces are corrected respectively for the foreign six-inch tube and for the ten-inch English tube. The objectives are all of wide angle, and are rather expensive, especially if compared with Zeiss's other list of lenses, though not so if compared with English and American first-class prices. The oculars known as "compensating eye-pieces" are all numbered on a new system, recommended by Professor Abbe, which give their magnifying effect on the simple magnification of the lens. For example, an inch lens magnifies alone ten times; if the eye-piece marked 8 is used with this, the total magnification will be 80 diameters.

I have been in the habit of using this plan myself, as it is so simple and convenient, and can strongly recommend it to others. It would be a great advantage if all opticians adopted it, and also if they made their eye-pieces so as to give whole instead of fractional multipliers. Mr. Zeiss's new eye-pieces are numbered 1, 2, 4, 8, 12, 18, and I think there is one of 27. They are so made that the length of tube is not altered in changing them, which is a great improvement, as objectives are corrected for a certain length of tube. They also can be used for ordinary medium-angled lenses, but are not recommended for extreme angles. Now that so much attention has been drawn to eye-pieces, it is to be hoped

that the bad ones will be driven out of the market, as a good eye-piece is necessary to do justice to an objective. Another advantage of the abolition of the secondary spectrum is that the lenses so constructed can be used for photography without the guess-work of altering the adjustment so as to bring the chemical rays into focus. Mr. Zeiss has brought out a projection eye-piece to be used in this work, but I have not tried it yet, so cannot give any opinion about it. This art of photo-micrography is one which has lately made rapid advances, but is still in its infant stage. To those of our members who want employment for long winter evenings I can highly recommend this branch of microscope work, especially as certain improvements in photography have made it more satisfactory. Everyone knows the advantage of a photograph, as it keeps a permanent record of one's work, which is free from the suspicion of being largely dependent on the imagination (a suspicion to which drawings are always liable). Most observers draw what they wish to see rather than what is actually seen. Besides having once got the negative, it is an easy matter to get any number of copies from it.

To glance at the technical part of photo-micrography, good rapid dry-plates are generally considered the best to use, and from these copies and enlargements can always be made. However, I am inclined to think that paper will be the coming thing for microscopists, and the following method might be made practicable, as the camera would not get rough usage :—Attach a simple and light roller-slide of small proportions to a very light conical camera, carrying at the end opposite the roller-slide either a projection eye-piece or else a simple tube, so marked that the image would be always properly focussed on the sensitive surface, and if this camera was so arranged as to take the place of the eye-piece when required, the microscopist could keep it near him while at work, and in a few minutes could shift it for the eye-piece, and take a photograph of any interesting object, developing the image at his leisure. He would thus soon acquire an interesting and valuable set of photographs. Now, if paper was used, there would be often no need for printing at all, as the negative could be placed in his album. The printing is often a most important point, and if the negative is large enough to be satisfactory and

the microscopist has time to print by daylight, the ordinary printing processes, albuminised silver paper, platinotype, and carbon printing are available for him; if he wants to print at night, Eastman's bromide paper and many other rapid printing papers are now procurable, giving excellent results.

If the negative is not large enough, he can enlarge either with a camera or with one of the lanterns made for the purpose, or else a home-made one, or by means of one of the magic-lanterns now sold. Thus he can get a direct positive on one of the rapid printing papers. For educational purposes an ordinary magic-lantern is excellent, and magic-lantern slides can easily be made from photo-micrographs, which are sure to give satisfaction if well managed. Another use of the optical lantern is to attach a lantern microscope to it, and in that way ordinary slides may be magnified and thrown on a screen. The ordinary objectives are used with this instrument, and as long as high powers are not used it is fairly satisfactory, though of course inferior to the microscope itself.

I must not, after all, exclude the ordinary mode of drawing by hand and the camera lucida, or else with a net micrometer, which is often more convenient. By this means those who have artistic tastes are able to produce very pretty pictures, which are certainly not less interesting because they show animals and forms of life which are unknown to people in general. This drawing by hand must always hold its place, as there are very many objects which it is almost impossible to photograph satisfactorily, besides which the camera takes everything in, as it has naturally no power of selection, and it often happens that only a small part of an object is required, and also that that part is partly concealed by other parts, which makes it unfit for photography, added to which it is no easy matter to make artistic photographs. The chief results of the last year seem to me to be the development of photography both in itself and in its reference to microscope work, and also in the interest taken in it by photographers who any way know what a photograph ought to be like, and who are thus able to give us most valuable help. Also, in this important discovery of extra dense glass by Messrs. Schott and Co., after long and laborious experiments, this glass must give us

a new weapon wherewith we can force Nature to surrender more of her secrets to us, as it must be of great advantage in the manufacture of lenses, since it is always easier to make a low power than a high one. No doubt, lenses will be cut on more perfect curves now that the index of refraction is increased.

In the practical use of a lens, a low power is always more readily used and corrected, besides being considered more satisfactory. Then it has the great advantage of not being so easily damaged. It is for us to make the best use we can of these new powers placed in our hands, and thus to help forward the science of microscopy. We ought not to despise the old methods and processes, but we ought to improve on them by grafting the new on the old, and bind them into a homogeneous mass by the use of our brains.

Microscopical study has the advantage of suiting every calibre of mind and taste, and to all it offers fresh knowledge and numerous untrodden paths, which are open to any student who feels a desire to enter into original research on his own account, and thus we can all make our lives useful and assist to build up the scientific knowledge of the world, and act up to the motto printed on the cover of our Journal, that "knowledge is not given us to keep, but to impart. Its worth is lost in concealment."

FORMATION OF PEARLS.—In oysters aged four years—which are judged by the shells, weight, and appearance—the best pearls are found. The shell, like the pearl, is formed by the secretion of the animal, and is composed of animal matter and lime. The iridescent hues on the inside of the shell are occasioned by the edges of the thin, wavy, concentric layers overlapping one another and reflecting the light. The minute furrows, containing translucent carbonate of lime, produce a series of more or less brilliant colours, according to the angle at which the light falls upon them. Occasionally, some of the finest pearls are found loose in the shell. As many as one hundred pearls have been found in one oyster, but are of little or no value. The pearls of the young oyster are yellow, and in the older oyster are of a pinkish hue.—*Bull. U.S. Fish Comm.*

Apochromatic Objectives.

By J. W. Gifford.

MUCH has of late been written about the new glass, and while some have exaggerated its advantages, others maintain that inasmuch as the secondary spectrum is removed, some of the best rays have been taken away, and that the image is therefore weaker than with ordinary achromatics.

Messrs. Powell and Lealand, having recently constructed a 1/10th apochromatic of numerical aperture 1·5 for the writer, who has also, through the kindness of Mr. Curties, of Messrs. Baker, Holborn, been able to compare it with several apochromatics by Zeiss, it occurred to him that a short description of the glasses and an account of the conclusions drawn might be of interest.

The tests used were the *Podura scale* and the *Tubercle Bacillus*, the beaded appearance of the latter when spore-bearing making an excellent test object.

The Apochromatics tried were :—

(1) 1/10 in. oil immersion, N.A. 1·5.

(2) 2·5 mm. water immersion, N.A. 1·25.

(3) 6·0 mm. dry immersion, N.A. 0·95.

No. 1 by Powell and Lealand, Nos. 2 and 3 by Zeiss.

These were compared with the following ordinary Achromatics :—

(1) 1/25 in., N.A. 1·38 }
(2) 1/20 in., N.A. 1·5 } oil immersions.
(3) 1/12 in., N.A. 1·43 }

(4) 1/8 in., N.A. 1·26, water immersion.

(5) 1/4 in., N.A. of 100° dry.

Nos. 1, 2, 3, and 4 by Powell and Lealand; No. 5 by Swift and Son.

The new compensating eye-pieces were used throughout, those by Zeiss magnifying 4, 8, 12, and 18 diameters, those by Powell and Lealand, 10 and 20.

The stands used were Swift's Challenge, with dry achromatic condenser, of aperture 180°, and Nelson-Curties's new Student's stand, as made by Messrs. Baker.

The results given by Powell and Lealand's 1/10 in. apochromatic eye-piece, × 20, and their 1/20 in. achromatic × 10 were almost indistinguishable. There was a little less colour with the 1/10 in., but the 1/20 in. gave, if anything, sharper definition.

Powell and Lealand's 1/25 achromatic of N.A. 1·38 and eye-pieced × 8 gave as little colour as the 1/10 in. apochromatic × 20, but the definition was not quite so crisp, doubtless on account of its smaller aperture. The same might be said of the 1/12 in. of N.A. 1·43 × 18.

Zeiss's water immersion apochromatic of N.A. 1·25 and 2·5 millimetres focal length, and Powell and Lealand's new formula 1/8 in. water immersion achromatic were then tested with these eye-pieces in the same way. The corrections for spherical aberrations with both these glasses were equally good, but the apochromatic by Zeiss gave an image almost entirely free from colour even with the highest-power eye-pieces.

Zeiss's dry apochromatic of ·95 aperture and 6 mm. focal length gave an absolutely water-white image even when used × 20, and was otherwise superior to 1/4 in. of 100° by Swift and Son, with which it was compared, but it did not give so flat a field of view. The 1/4 in. of 100° by Swift is the best 1/4 in. of the ordinary achromatic type the writer has seen; the Zeiss dry apochromatic had, however, the advantage in point of aperture.

The results obtained with Powell and Lealand's 1/10 in. apochromatic and their 1/20 achromatic, and also with Zeiss's, and Powell and Lealand's water immersions seemed rather to lean towards the view that by eliminating the secondary spectrum some of the resolving power is lost. On the other hand, the apochromatics are more pleasant to work with and better adapted for photo-micrography, though a projection eye-piece does much in this respect for the ordinary glasses.

On the whole, the advantage to be derived from apochromatic lenses seems smaller than has been anticipated. As has already been noticed by Dr. Dallinger, the compensating eye-pieces are perhaps the more important factor in the advance made.

Ordinary achromatics have been brought to such a state of

perfection as to leave little to be gained until some method of further increasing the aperture has been worked out.

It has occurred to the writer that media having a higher refracting index than cedar-oil, might be used with advantage with immersion objectives constructed for the purpose.

It is a fact well known to opticians that the extreme marginal rays with glasses of wide aperture give no image; experience proves, however, that there is a decided gain in increasing the aperture even up to N.A. 1·5.

Is not this due to the fact that the last ·1 or more of aperture is never utilised, and although we may get no more light through the lens than would give an aperture of 1·52, by using an immersion medium of 1·6 or more, might we not so compress the cone of rays passing through as to make the marginal rays up to the extreme limit of 1·52 enter the front at a sufficiently favourable point to be effective?

THE TARANTULA AT HOME.—Herr von Bergsö, in a recent work has given some interesting data respecting the habits of the Tarantula, *Lycosa tarentula*, whose nests he has traced and examined on the Roman Campagna. He found that the nest, which was well rounded and smooth, was approached by a tunnel which, after running about a foot straight down below the surface of the ground, made a sudden short turn before it finally descended for about another foot into the spider's abode. The entrance to the tunnel is concealed by an arched covering made by the interlacing of grasses and leaves. The eggs are enclosed in a spun bag, and the young appear in the autumn, when they immediately seat themselves on the body of the mother where they remain till about April, neither parent nor offspring seeking food during their hybernation. As many as 291 individuals were on one occasion removed in February from the body of an emaciated tarantula. The superstitious error of assuming that the bite of the animal induces an irresistible desire of dancing is due to the fact that dancing having been originally employed as a remedy against the poison, which is believed to be eliminated by profuse perspiration, the action of the poison was confounded with the means of its eradication.

The Hessian Fly

BY "ENTOMOLOGIST."*

THE British farmer has been talking of the Hessian fly ever since the period of the American Revolution in the days of good King George, and it is hard upon him that the insect should actually appear on these shores now, at a time when the agricultural interest is so depressed, though it is Queen Victoria's Jubilee year. But it was observed to occur in more than one locality last year, though some entomologists had a doubt whether another species had not been mistaken for this notable fly; for in the same group of insects are several, also foes of the cereal crops, and in appearance, or even in habits, not unlike the much-dreaded pest. We may accept it, however, as an incontrovertible fact, that up to the year 1886 none but straggling specimens occurred in England (if any), though the insect has been known as one of the most destructive amongst the "blights of the wheat" for just a century. It should be stated, perhaps, that the appellation of the "Hessian fly" arose from a notion that the German mercenaries brought the plague into the United States, but this was proved to have been impossible. From 1786 onward, however, the Hessian fly has caused enormous destruction of corn in the American Continent, and extended itself over a great part of those regions where grain is an important crop. It has been conjectured that the primitive habitat of the fly is on the borders of Europe and Asia—*i.e.*, about the shores of the Mediterranean, but this appears to me very unlikely, seeing that it was first found to be doing mischief in America, and I would rather assign it to that country. In Europe there is no record of its occurrence until 1834, in Minorca, or possibly 1883, in Hungary; it is reported from France, Austria, and other countries now, the south of Russia being the last where if has caused alarm, but in the Old World as yet the injury done is trifling compared with the New, and all the researches of the American scientists and the persevering efforts of growers have failed to put an effectual check on its yearly propagation and ravages.

* From *The Journal of Horticulture.*

Having thus touched briefly upon its general history, I proceed to describe the structure and habits of this fly, called in science, very aptly, *Cecidomyia destructor*, and we have the advantage of Mr. Meade's examination of British-bred specimens, as recorded in the "*Entomologist.*" The perfect insect has the head and eyes black and hairy, the antennæ are rather long and brownish, the proboscis small and pink, the thorax black, with two red streaks running from the neck to the base of the wings, the abdomen reddish brown, with regular black spots, which coalesce in some specimens, the legs pink, sprinkled with blackish hairs, the wings, transparent as usual, are also hairy. In the male flies the wings are longer and appear of a reddish tinge, and the legs are paler, but the females, on the whole, are the larger, and they seem to be more abundant than the males. The number of eggs laid by each female has been variously stated between ten and fifty : probably the smaller estimate is nearer to the average, if the size of the egg is correctly reported. Like the larva of all flies, the maggot of the Hessian fly is legless, but it has just below the head a curious process or appendage, which the American observers call the "breastbone." It is found in several species of *Cecidomyia* ; the use is not known positively, but no doubt this in some way aids the larva in acquiring its food, the mouth-organs being somewhat feeble. This maggot is oval and glossy, with the head not very discernible ; its skin dotted over by a number of tiny tubercles, in colour white or greyish. To the chrysalis or pupa the name of flax-seed is familiarly applied, from its likeness to that object. This, however, is really the cast-off integument of the maggot, forming a puparium, in which the true pupa lies to await its transformation to a fly. This puparium is brown, spindle-shaped, flattened, and each end is bluntly pointed. This pupa stage is of special importance, for the puparia are hidden in the stalks of the cereal, solitary often, sometimes two or three together, and it is by this agency the species travel from one district or country to another, as the flies themselves do not take long journeys.

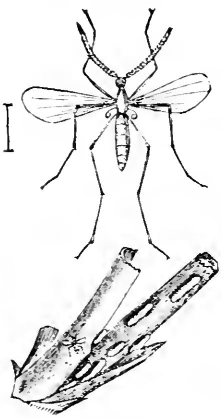


FIG. 1.

In most places where the Hessian fly has been under notice two broods occur yearly, and the economy of the species is as follows, it being premised that the second brood is that of which we know more from the obvious results of its attacks :—The autumn flies emerge in August or September from the pupæ, which are almost invariably found above the second joint of the straw from below, and seek out the young wheat or barley (it is one of

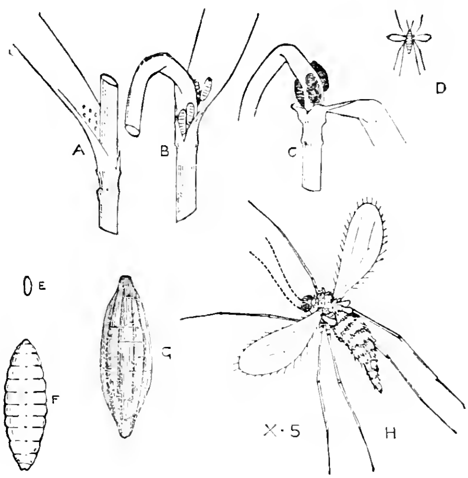


FIG. 2.

these the fly chiefly attacks) ; placing eggs on the sheath or young leaves, the larvæ work their way gradually into the plants, which die off about the time the insects turn to pupæ, in which state the winter is passed. Emerging about April, the next brood of flies finds the crop in an advanced stage of growth, and the larvæ produced in May feed in, or between the sheath and the stem. Here they lie in small parties of six or eight (Fig 1), and the stem, when they are increasing in size, bends at an angle and not unfrequently breaks at the point where the attack has been made, the ear, if formed, containing but a few dwarfed grains. By the time the corn is cut, or soon after, the insect has completed its larval existence and is ready to journey elsewhere in its form of "flax-seed" during the autumn, for it does not seem probable that the pupæ or "flax-seed" which are produced from the spring wheat scatter to any distance.

As full particulars concerning last year's visitation of the Hessian fly have appeared in many journals, it is only needful to say that the first specimens noted in 1886 were forwarded to Miss Omerod from barley-fields near Hertford. Subsequent reports of its occurrence came from three other places in Hertfordshire, from Romford, Essex, and Luton, Bedfordshire. Later in the season the fly was found north of the Tweed near Inverness, and near Crieff, localities where its appearance is certainly singular. Though no complaints that I am aware of were made with reference to the spring brood on the early corn, it must have bred to some extent, for early in the summer of this year wheat and barley were found to be infected in several of the places which had produced the insect last year, and by degrees intelligence has been received of a number of fresh attacks, the districts being often wide apart, and as before both in England and Scotland. Mostly they are not spread over a wide area, I believe, except in South Lincolnshire, which has suffered considerably. It is not supposable that all these localities have been infected by the progeny of the flies noticed last year; we must conclude there have been new importations of the enemy. "Where has the attack come from?" asks Miss Omerod, and Echo answers, "Where?" It is mysterious, but there can be no dispute that in the "flax-seed" or pupa state the insect must have come to us from the Continent or from America. Probability points to the former. That we should have escaped hitherto may be deemed an encouraging circumstance for the future, as we may hope the climate of Britain is not particularly favourable for this fly, or it would have got a lodgment before, since the pupæ must have been brought over by accident. It is considered as proved they do not come in grain; they must therefore travel in the straw, either when that article is imported as cargo, or when it is used for packing. An examination of what is called "corn rubbish" has yielded "flax-seeds," so that this medium may convey the insect from one locality to another in Britain. As yet, however, I cannot say it is clearly made out how pupæ contained in foreign straw can be distributed over our corn-fields. One way that has been suggested is this—To London, and to some other towns, quantities of goods are sent from various countries of Europe packed in straw; the surplus of this is sold off

by wholesale houses, and next reaches stables, where it is finally converted into manure, and then is made use of by farmers or market-gardeners. If so, we ought to have the Hessian fly about Kent, especially near the Thames and the Medway, for we receive much London manure. We are also in frequent communication with the Continent, but I have no report of it at present. Possibly the Kentish soil does not produce a growth of wheat and barley agreeable to the insect, owing to its being generally chalky, and it may thrive best where the plants are on clayey or loamy soil. And it has been surmised that the Hessian fly is a lover of moisture; if such be the case, then we may presume that had 1887 been a wet instead of a dry summer, we should have found a greater abundance of the insect.

To the above interesting account of this destructive enemy to important crops we append illustrations, representing its various forms, with explanatory notes, for which we are indebted to Messrs. E. Webb and Sons, Wordsley, Stourbridge, in whose farm-seed catalogue the figures appear with a history of the enemy, and suggested methods for preventing its attacks:—

"In the illustration (Fig. 2) we have shown natural size of A, B, C, and D, the eggs, maggots, chrysalids, and perfect insect belonging to the Hessian fly. Underneath at E, F, G, and H, the same stages of growth are shown enlarged five diameters. The eggs are shown at A, at the base of a wheat leaf; at B the maggots, often six or eight in number, have emerged from the eggs, and are shown as grown to fully mature examples; at C the maggots have fixed themselves close to the stem, and after a lapse of five or six weeks have taken on the brown chrysalis or 'flax-seed' condition; at D the perfect Hessian fly is shown as it emerges from the chrysalis—*i.e.*, when the latter is about ten days old. The mischief is caused by the maggots, which fix themselves on the young corn, or when the corn is older, near the three lowest joints of the stem or close to the root, and there suck the juices of the plant. The effect of this injury is that young plants are killed, and the stems of older plants are so greatly weakened that the ears only produce a few grains at most, and the corn stem itself commonly bends abruptly down to the ground, either from the root or from one of the joints a little above it."

Micro-Organisms as Parasites.

By Mrs. Alice Bodington.

IN a scientific journal an apology is hardly needed for introducing this most interesting subject to the reader, though the field which it covers is so vast that only a small portion of it can be treated in one paper. All who have followed, however imperfectly, the patient and laborious researches of the great scientists, who have given up their lives to the study of micro-organisms in disease, all such students know how fascinating it has been to watch the flood of light which has been poured over some of the darkest secrets of medicine. It is, perhaps, not too much to say, that these researches into the part played by micro-organisms in disease have laid the very foundations for a science as distinguished from the art of medicine. Formerly, when men spoke of infection, they spoke of they knew not what, they combated they knew not what, and often, as in the exhaustive bleedings practised in fevers, they actively aided the enemy they sought to destroy. Now, the microscopically minute foe is being hunted out, his whole life-history in many cases made known, and the most efficient means devised for expelling and exterminating him. Medicine has no longer to grapple with an unknown and invisible foe.

I will now attempt to give a brief history of a few pathogenic micro-organisms, and of the diseases to which they give rise. I propose to divide these micro-organisms into two classes: first, those which having entered the human body are ineradicable, and the only end to whose ravages is death; secondly, those which keep up a warfare in our systems, and either destroy or are destroyed. Foremost in the first class, both with regard to its historical importance and the extent of its ravages, stands *Bacillus Leprae.*

Of all the terrible diseases which have afflicted mankind, no one has been so universally dreaded as leprosy. Though the contagiousness of this disease has lately been considered doubtful, yet its horrible and incurable character made the possibility of contagion

a subject of unutterable dread in earlier ages. The Mosaic law abounds with the severest enactments for the banishment of the leper from the society of his fellow men, and for the destruction of all his goods. He was to rend his clothes and to bare his head as he cried, "unclean, unclean," and he was to "dwell alone, without the camp."

The original habitat of leprosy seems to have been Egypt, and it was brought thence into Europe by the victorious Romans. By the first century after Christ it was established in Italy, and from there spread to all the western countries under Roman rule—Spain, Gaul, and Britain. By the 7th century it was established in Germany and Switzerland. Leper-houses existed at Verdun, Metz, and Maestricht in the 7th century, and at St. Gall in the 8th, and Pepin and his great son, Charlemagne, made laws regulating the mode of life of lepers. But it was amidst the stir and movement of the Crusades that the ravages of leprosy became frightful and almost incredible. In Western Europe alone it was estimated that 19,000 leper-houses existed, most of them being religious and dedicated to St. Lazarus; in France, there were at least 2,000; and in England, with its scanty population, there were "95 houses of the first class."

The isolation of lepers was most strictly enforced both by law and by popular sentiment. The greatest or the meanest of mankind smitten by leprosy was driven from the society of his fellow creatures for ever. Alms and food were left where he could fetch them, but his presence, being felt as a deadly danger, he was provided with a large wooden clapper, by which he was bound to give warning of his approach, that all might flee from him. A poet monk of the middle ages, whose songs all Germany was singing, was nevertheless one of these pitiable outcasts; he is described as "Aussätzt"—thrust out from amongst the people (der ward von den Leuten aussätzig). Cruel as this life-long banishment was for the victims of leprosy, the stern policy adopted seems to have been successful in its aim, for in the 15th century the disease had already declined, and in the 17th had mostly disappeared. It survived in a sporadic form in a few isolated places, and it is not yet extinct at Bergen in Norway, where all its characteristics may be studied, unchanged by the lapse of

thousands of years. This terrible disease, whose history I have imperfectly described, is now known to be caused by a bacillus which takes up its abode chiefly in the lymphatic vessels and the deep tissues of the dermis. Not only is it never found in the epidermis, but, as MM. Cornil et Suchard say, "the epidermal covering forms a varnish impenetrable to the special parasite of leprosy." Fortunately for us, the same may be said of the epidermis, *when uninjured*, with regard to many other diseases.

The anæsthesia characteristic of leprosy is found to arise from enormous groups of cells, containing bacilli, which lie amongst the peripheral nerve-endings. The bacilli also invade the epiglottis and the thyroid cartilage, thus accounting for the peculiar hoarseness of the voice in leprosy. The *bacillus lepræ*, one of the oldest and most fatal enemies of the human race, is an extremely faint, slender rod about half the length of a human blood-corpuscle. It closely resembles *bacillus tuberculosis*, except in being slightly wider in comparison to its length. Without staining, the bacilli are so small and faint as to be unrecognisable. What incalculable pains have been taken in discovering the properties of aniline and other dyes in staining (and thereby revealing the existence of) micro-organisms, can best be realised by those who have read Koch's description of his discovery of the bacillus of *Septicæmia* in the mouse, an organism so small that it can swarm inside the red blood-corpuscles of mice. By numberless patient and most delicate experiments, it was found out that organisms otherwise too small, colourless, and delicate to be visible by the strongest powers of the microscope, became easily recognisable when suitably stained; each micro-organism having an affinity for some particular dye. Moreover, the protoplasm of cells takes one colour, the nucleus another, the cell-wall (in vegetable cells) a third, and the bacilli, when present in the cells, a fourth. In Neisser's experiments on the lepra bacillus, the ordinary cell protoplasm was stained rose-eosin; the nuclei were found to be blue, whilst the protoplasm of cells which contained bacilli was coloured a bright orange; the bacilli, being less deeply stained, were visible with a comparatively low magnifying power.

With regard to the question of the contagiousness of leprosy, I will quote the concluding words of MM. Cornil et Suchard,

who have made the subject their special study:—"The tubercles of leprosy, formed by a solid, dense, dermic tissue, are made of large cells filled with bacteria. *The layers of the epidermis are free from parasites*, but are (from pressure) becoming constantly thinned. *So long as it is preserved*, the layer of epidermis opposes the diffusion of the parasite outwards, and constitutes a barrier to its progress. It renders contagion very difficult." When, however, the thinned epidermis gives way, and an open ulcer is formed, it is easy to see how readily fatal contagion might arise if there were the slightest cut or other injury to the epidermis of a person coming in contact with a leper.

The bacillus of leprosy has not yet been cultivated outside the human body, nor is it communicable to the lower animals. It has taken possession of its human host so long, that it is apparently not to be found in a wild state (if I may be allowed the expression). Many of the larger parasites of man and the lower animals pass their whole cycle of existence in or on their host, so the lepra bacillus forms no exception in nature.

In spite of all evidence existing to the contrary, many persons will doubtless continue to refer leprosy to some unknown cause, rather than believe it owes its origin to a bacillus universally found in this disease and in no other, from Norway to China, and from Honolulu to San Francisco, in cold climates and in hot, in wet soils and in dry. I am tempted to say with Dante, "Non ragionam di lor, ma guarda e passa." I am not aware that any other strictly human parasite is invariably fatal to life; glanders is always, and anthrax usually, fatal to life, but the micro-organisms of these diseases reside normally in animal hosts, and only by accidental contagion prove fatal to man.

I come now to a disease which, terrible as have been its ravages, experience proves can be guarded against with extraordinary success. I speak of Asiatic cholera. When it first came with giant strides from the east, thousands upon thousands of human beings were its helpless victims. The resources of medical skill seemed exhausted: the most apposite remedies were tried, and all failed alike. Men knew not how to grapple with the terrible new foe. Amongst the simple and superstitious peasants of Brittany, the cholera was thought to be brought by demons, which the

terrified people actually believed they saw. M. Emile Souvestre asked the *curé* of a country village, in the Lyonnais (Brittany), what precautions his flock had taken against cholera. Slowly and silently the poor priest led his friend into the churchyard, and there showed him twelve open graves. That was the only preparation of which these poor creatures could think, and so terrible was the pestilence when it came, that carts and horses failed to convey the number of victims, and wives and mothers were to be seen bearing their beloved dead to their last resting-place. Gradually it came to be recognised amongst the educated classes that cleanliness was a deadly foe to cholera; that where the drainage of a place was good, and above all where the water supply was pure, safety might reasonably be expected. We can hardly assert that it has been the superior piety and virtue of the English which kept our country free from cholera during the late fierce outbreak (1886) in France, Italy, and Spain. Our drainage and our water supply leave much to be desired, but they are incomparably better than the drainage and water supply of most continental towns and villages, more especially those of Southern Europe.

The patient and prolonged investigations of Koch have satisfied many minds as to the fact that cholera is caused by the presence of a specific micro-organism in the intestines, the *Spirillum Choleræ Asiaticæ*, popularly known as the *Comma Bacillus*. In the very latest scientific journals (August, 1887), and those of the highest character, the fact is assumed as proved. New particulars are given as to the life history and peculiarities of *S. Choleræ Asiaticæ*, but no one thinks of disputing the right of this *spirillum* to its distinguishing name. Of the difficulty of the task undertaken by Koch, he speaks thus:—"When I undertook this commission (from the German Government) I was well aware of the difficulty of the task before me. Absolutely nothing was known with regard to the virus of cholera, and I was at a loss where to seek for it, whether in the intestinal canal, or in the blood, or in some other place. Further, one did not know whether bacteria would have to be dealt with, or some kind of fungus, or an animal parasite, such as an amœba. Even the description of *post-mortem* appearances given in the text-books

proved utterly erroneous and misleading." Suffice it to say that Koch went out to Egypt and to India, that he examined nearly a hundred specimens of choleraic infection, and likewise examined, with the minutest care, cases of typhoid and typhus fever, dysentery, and intestinal catarrh. In all the former cases the comma bacilli were present; in all the latter they were absent, although the *post-mortem* appearances in typhus resembled those of cholera in a marked degree. Koch, therefore, came to the conclusion that the bacillus found in cases of cholera, and of cholera alone, were the exciting cause of that disease, hitherto supposed to be due to an "organic poison," which had a preference for living in the earth. (See Quain, "Dictionary of Medicine.")

Nothing could be more strange than the way in which the merest novices in microscopical work rushed into print to say that Koch was mistaken. An experienced biologist would weigh his evidence anxiously before venturing to break a lance with one of the greatest scientists on his own ground, but as the homely proverb says, "Fools rush in where angels fear to tread." Dabblers with the microscope found a comma-shaped bacillus in the mouths of healthy persons, and rushed to the medical journals to announce the discovery, and to say that Koch's comma bacillus could be found everywhere and every day. Had they merely read his paper once, and remembered what they had read, they would have known that one bacillus being often much like another, its life-history must be patiently studied before its identity can be proved. The comma bacillus of cholera, sown in a flask of gelatine, behaves in a manner peculiar to itself. As the colony of bacilli grow, they liquify the gelatine on which they rest, and sink further down into it, causing a *funnel-shaped depression.*

Nothing can be stranger than to read the peculiarities of constitution of each kind of micro-organism, when its life-history is studied. The comma bacilli prefer a temperature of from 30° to 40° C., but they are not extremely particular in this respect. They "do quite well," as Koch says, at a temperature of 17° C., though under 16° C. their growth stops altogether. They bear freezing perfectly well. As food they enjoy strong soups, nourishing jellies, and milk; in weak broth they do not thrive at all. Though

they easily accommodate themselves to extremes of temperature, and are with difficulty killed by either heat or cold: they are peculiarly sensitive to other influences. They will not grow without air or in an atmosphere of carbonic acid, but they are not destroyed. But one thing is fatal to comma bacilli, and that is to be dried. This peculiarity was found out accidentally. Droplets of meat-infusion containing comma bacilli had been placed on cover-glasses, and allowed to dry. On being examined, no growth was found upon any cover-glass; all the germs were dead. This was the more surprising to Koch, because the bacillus of anthrax, which in many respects resembles that of cholera, can be dried with impunity. To be dried for two hours is fatal to most, and for three hours is fatal to all cholera bacilli.

Their constitutional peculiarities also give a clue to the reason of the recovery of cholera patients, even from the stage of collapse. The bacilli grow with extraordinary rapidity; cultivated with other bacteria they quickly outgrow them, and this rapid growth lasts for about twenty-four hours. But in two, or at the most three days, the comma bacilli die, and the other bacteria which may be present survive them. If the patient, therefore, can survive his internal enemies, he has a chance of recovery. This life-history forms a strong contrast to that of the bacillus of leprosy, which can live and ceaselessly multiply for eight or ten years, and dies—if even then it dies, only with its human victim. The use of disinfectants has also been placed on a scientific basis by the study of the individual constitutions of micro-organisms. The cholera bacillus, for instance, will not develop in infusions containing alcohol, 10 per cent.; camphor, 1 part in 300; carbolic acid, 1 part in 400; quinine, 1 part in 5,000; and corrosive sublimate, 1 part in 100,000.

The inhibitory action of quinine upon micro-organisms gives us a clue to the *reason* of its action as a specific in fevers. And before leaving this subject, I should like to refer my readers to a profoundly interesting paper on the action of quinine on the hematozoa of malarial fever, by Dr. Osler, of the University of Pennsylvania, which appeared in the *British Medical Journal* for March, 1887.

I will now return to the comma bacillus, and the question of its

native home. Notwithstanding the most patient researches, Koch could not find the cholera bacillus in tanks which had been polluted through the horrible disregard of all sanitary rules, shown by the native Hindoos. On the bank of one such tank during an outbreak of cholera, Koch found from 30 to 40 huts, containing between 200 and 300 persons. The natives bathed daily in the tank, drank of the water, and washed their clothes in it, and it was the only receptacle for all drainage. The epidemic had already reached its height when comma bacilli were found in the tank, and their appearance in this case followed the epidemic. Where, then, are we to look for the original source of these outbreaks of disease? Koch says, "All authors are agreed that the delta of the Ganges is the true home of cholera, and I have come to the conclusion that this is the case. For the only district of India where cholera prevails year after year is the delta of the Ganges. In all other parts of India it shows marked variations, and may even disappear altogether for a longer or shorter time." On the map of the province of Bengal you can see this delta of the Ganges, bordered on the west by the Hoghli river, and on the east by the Brahmaputra. Over the whole of this district cholera continually prevails. On closer examination of the map it must strike one that the upper part of the delta is thickly covered with towns, while the base of the triangle remains uninhabited. This uninhabited stretch of land, called the Sunderbuns, embraces an area of 7,500 square miles. Here the great rivers Ganges and Brahmaputra break up into a network of water-courses, in which the sea-water, mingled with river-water, flows hither and thither with the tide, and at flood-time places large tracts of the Sunderbuns under water. A luxurious vegetation, and an abundant animal life, have developed in this uninhabited region, which is inaccessible to man, not only on account of the floods and the numerous tigers, but on account of the pernicious fever, which attacks those who venture into this region even for a short time. Here the cholera bacillus would find the most favourable conditions possible for implanting itself, where all the drainage from a thickly-populated country is washed down by the current and mingles with the brackish water of the Sunderbuns, already teeming with decaying matter. Jessore, from which the epidemic

of 1817 originated, lies on the borders of this vast, infectious marsh, and Calcutta, which is now the fixed home of cholera, is connected with the neighbouring Sunderbuns, by a marshy tract of land.

From its original home the cholera is carried by the enormous bands of pilgrims, who travel yearly to the sacred cities of India, and by the Mahometan pilgrims it is carried to the sacred cities of Arabia. Here the tide of pilgrims from India meets the tide of yearly pilgrims from Egypt and other Mahometan countries, and thus the infection reaches the Levant, and thence spreads to every European seaport where it can find a congenial resting-place. I was once in the midst of a severe epidemic of cholera at Gibraltar, in 1865. We watched the advance of the disease; first it was heard of at Cairo, then at Alexandria, next it appeared at Malta, and we felt the turn of Gibraltar would come next. A regiment, apparently uninfected, came from Malta; it camped on the neutral ground, a narrow neck of land connecting the rock with the Spanish mainland. In a fortnight the regiment embarked for the Cape, and in ten days' time cholera broke out violently in Gibraltar, and (as we afterwards heard) broke out on board ship in the regiment which was on its way to the Cape. I was much struck at the time with the fact that no officers, or their wives, or their children were attacked, though the poor soldiers died like flies. The food of all inhabitants of the rock came from the same market; whence then came the immunity of the officers and their families? *Our water supply was perfectly distinct;* we drank rain-water collected in tanks, removed from all possible contagion by drainage. It was impossible, even then, not to arrive at the conclusion that an uncontaminated water supply was the secret of our escape, though our knowledge at that date could only be empirical.

To return for a moment to the Hindu pilgrims. They are crowded for weeks together by thousands in the narrowest space; the same tanks serve for drinking, bathing, and washing clothes; and under these circumstances who can wonder that cholera, when once developed amongst the pilgrims, travels quickly over the whole of India? This source of evil has of late years been much diminished by the stringent sanitary regulations of the Indian Government.

It is hardly necessary to say that cholera is one of those diseases, where the conflict of the bacillus with the organism it has invaded is swift and sharp, a pitched battle ending soon in victory or death for one side or the other. The same may be said of typhoid, scarlet, and yellow fever, measles, diphtheria, small-pox, and pneumonia. Not only is the bacterium exterminated in the system in cases of recovery in the latter diseases (with the exception of pneumonia), but the field in which it grew seems exhausted of the necessary nourishment required by the parasite, and it is uncommon to see a person attacked a second time by measles, scarlet fever, whooping-cough, and other zymotic diseases. Of the manner in which the living tissues proceed to attack the dangerous invaders of the body, Mr. Bland Sutton gives a most interesting account, founded (as we may expect to find in such researches) upon the most minute and patient investigations on his own part, and on that of the foreign pathologists, on whose authority Mr. Sutton says "The leucocytes (familiarly known as white blood-corpuscles) may be likened to a defending army; the blood-vessels are their roads and lines of communication. Every composite organism maintains a certain proportion of leucocytes, as representing its standing army. When the body is invaded by bacilli, bacteria, micrococci, chemical, or other irritants, information of the aggression is conveyed by the vaso-motor nerves, and leucocytes rush to the attack; reinforcements and recruits are quickly formed to increase the standing army, sometimes twenty, thirty, or forty more than the normal standard. In the conflict, cells die, and are often eaten by their companions; frequently the slaughter is so great that the tissue becomes hardened by the dead cells, in the form of pus; the recent activity of the cells being testified by the fact that *their protoplasm often contains bacilli, etc., in various stages of destruction.* These dead cells, like the corpses of soldiers who have fallen in battle, later become hurtful to the organism which in their lifetime they strenuously endeavoured to protect from harm. They are fertile sources of septicœmia and pyœmia, the pestilence and scourge so much dreaded by operative surgeons." The analogy may seem at first a little romantic, but its correctness will be shown by the facts which will be placed before the reader.

The line of enquiry which has led up to the discovery of the function of leucocytes as destroyers and devourers of foreign particles, injurious or unnecessary to the body, was begun by Haëckel, who watched the corpuscles of a naked sea-snail eating up particles of indigo, in amœba fashion. He subsequently watched the same process in the colourless blood of other invertebrates. Many other observers continued this line of investigation, the most eminent and successful being the Russian scientist, Metschnikoff. He found that the white cells of numerous invertebrate animals devoured finely divided particles of carmine, also disintegrated bodies of entomostraca, human blood-corpuscles, milk globules, starch granules, etc. But more extraordinary and important discoveries were to come. I will give in detail his experiments on *Daphnia* (the water-flea). He kept many of these little creatures in a tank, and after a time he found them infected with fungus spores, which germinated and were dispersed by the blood-current over the body. They were deposited in those parts where the blood-current is slowest, and in these places (the cephalic and hinder portions of the mantle cavity) heaps of conidia collected. In the meantime the leucocytes did not remain idle during the invasion; they attacked and devoured the conidia, took them into their interior, and digested them. If a conidium were too much for one cell, others joined it, and fused to form a giant cell or plasmodium, the better to exterminate the invader. Notice this especially, for further experiments have shown that the same rule holds good for every organism, whether animal or vegetable. "If the leucocytes finally overpower the spores, the *Daphnia* lives; if not, the spores over-run the crustacean, and death is the result."

In the *B. Medical Journal*, a house-surgeon described his experience with one of the fresh-water Algæ, *Chara*, which with other pond weeds he kept in a glass jar placed in a hospital ward. Soon he saw the *Chara* begin to drop, and the other water-plants died outright. After two or three days the *Chara* began to revive, and resumed its bright-green colour. The surgeon then examined the water of the jar, and the tissues of *Chara*. He found, as usual, in water kept in a hospital ward, that it was full of septic organisms. The dead plants swarmed with *living* bacteria, but

the cells of *Chara* were full of *dead and dying bacteria;* the plant had had a hard fight, but was victorious. To return to Metschnikoff's experiments, this time with a vertebrate animal. The leucocytes in the lymphatics of a frog not only devour anthrax bacilli, but called in other leucocytes to their aid. Illustrations of the whole process, which occupied 40 minutes, will be found in Mr. Bland Sutton's Lectures on Pathology. In *Botryllis* Metschnikoff found a *spirochæta* closely resembling that of relapsing fever, and a small bacillus resembling the lepra bacillis. Both these organisms were pursued by leucocytes, ingested and absorbed by them. Some leucocytes perished in the attempt. In the same way Koch found *bacillus anthracis*, and the bacillus of *septicæmia* in the mouse, enclosed by white blood-cells. Throughout the whole animal kingdom these cells use their ingestive powers for destroying bacteria and similar organisms.

These amœboid cells exhibit a very curious power of throwing out pseudopodia, which unite with similar protrusions from neighbouring amœboid cells, until a considerable mass of protoplasm is formed by their influence. Such a mass of fused cells is known as a *plasmodium*. Metschnikoff has watched their formation in a transparent mollusc *Phyllirhöe*, around masses of carmine granules. He writes: "The cells came one by one to each lump, and flattened themselves upon it, fusing with neighbouring cells as these arrived. In this way arose plasmodia of different sizes, some even visible to the naked eye, *which might be compared to the giant-cells of vertebrates*." He adds, "In all cases in which I have found giant-cells in invertebrates, they have arisen round foreign bodies, and always by fusion of separate cells." Mr. Bland Sutton remarks, "In such diseases as tubercle, leprosy, and the tuberculosis of the fowl and ox, there is a peculiar cell to be detected, the giant-cell; and in cases where bacilli have been discovered in the tissues, these micro organisms have been found to occupy the interior of the giant-cells, sometimes in enormous numbers."

This view is remarkably confirmed by Koch, who says, in his paper on the Etiology of Tuberculosis—"Direct observation seems to show that on their first entry into the system, the tubercle-bacilli are seized upon and carried away by wandering cells. If an

animal be killed soon after infection, the blood is already found to contain numbers of white blood-corpuscles, enclosing one or more of the tubercle bacilli. A wandering cell which has taken up a tubercle bacillus has no such harmless burden as if it had devoured a particle of vermilion or carbon. With the latter load it might travel a long distance, but under the poisonous influence of the bacillus, changes take place in the white corpuscle which soon bring it to a standstill. It increases more and more in size by continuous multiplication of its nuclei, and at length attains the form and size of the well-known giant-cell. Specimens properly prepared show all the intervening stages between simple epithelioid cells, containing only one bacillus, and fully formed multi-nucleated cells containing many bacilli."

The further fate of the giant-cell varies. When the course of the disease is slow, the number of bacilli enclosed in the cell remains small; in the most favourable cases the giant-cell remains, and the bacilli die out. But when the course of the disease is rapid the bacilli multiply rapidly, push through the wall of nuclei, and the giant-cell succumbs. The behaviour of the bacilli in the giant-cells is also most curious. The "idea involuntarily arises in the mind," says Koch, "that there is a kind of antagonism between the giant-cell and the parasites it contains. Where one bacillus only is present, we often find the nuclei of a giant-cell collected together at one end, and the bacillus generally in the part of the cell free from nuclei, at the furthest point of the unoccupied pole. But when the number of bacilli is increased, their behaviour towards the nuclei becomes more actively hostile. They crowd more and more towards the periphery of the cell, push between the nuclei, and finally break through the wall formed by them. A considerable increase like this in the number of bacilli seems always followed by the degeneration of the giant-cells and their disappearance, leaving only groups of radiating bacilli to show where they once existed." These facts seem to show that the modern treatment of consumption (though begun, perhaps, empirically) rests on a true scientific basis. In the pure, cold air of mountain regions, or in the equally pure air of the open ocean, the consumptive patient has to grapple only with the bacilli contained in his own system; there are no fresh spores in the atmosphere ready to seize

upon diseased lungs. The system is braced up with as much nourishing food as the patient can digest, and the giant-cells are strengthened as much as possible for their battle with the enemy. Under the old system, the poor victim of phthisis breathed constantly a warm, close, spore-laden air, whilst lowering medicines were employed to help the progress of the disease as much as possible. Yet, it is seriously asked whether medicine has made any progress during the present century !

Not only do leucocytes attack and devour bacteria, but they perform important duties in removing useless embryonic tissues. In the process of absorption of the gills and tails of larval Batrachians (frogs, newts, etc.), a large number of these cells are present, the protoplasm of which is crowded with fibres and fragments of muscle. The fragments of muscle retain their structure for some time after ingestion, but gradually break up into rounded, strongly refracting globules. These experiments, originally made by Metschnikoff, are confirmed by Mr. Bland Sutton in every particular. We have ample proof, in even the present state of our knowledge, that the air, the water, and the earth, and also our own bodies, teem with micro-organisms. Of these, however, comparatively few are pathogenic, and an immense number are not only useful but necessary. Bacteria are very quickly destroyed in the blood of warm-blooded animals (if not pathogenic to the particular animal). Herr Wysskowitch has found that in from 3 to 4½ hours no traces were found of various bacilli, and spores of fungi which had been ingested into the blood ; these included the bacillus of typhus, the cholera bacillus, and other pathogenic organisms. Herr Wysskowitch says, "Between the endothelial cells and the bacteria there is a constant warfare. Either the cells conquer and the bacteria perish, or the cells are destroyed by the bacteria, which are of course in this case pathogenic to the animal. Similar testimony is given by Herr Ribhaet, in the *Journal of the R. Microscopical Society* for August.

As I remarked at the beginning of this paper, we need no longer feel we combat we know not what, and consequently run less risk of aiding the enemy we seek to destroy, as must have been the case when repeated bleeding and starvation were

relied upon as remedies for fever, and calomel, with close confinement to hot, airless rooms, was thought the best treatment for consumption. By bleeding, the dauntless, active little soldiers, which sought to save the organism of which they formed a part, were ruthlessly drained away, and the weakened patient only escaped death by a species of miracle! In most of the intensely infectious zymotic diseases, the contest is of the nature of a pitched battle, and in the white races, with a fair chance of victory on the part of the patient. Where, however, the micro-organism finds itself in virgin soil, as amongst the natives of the South Seas and the Red Indians of North America, its ravages resemble those of the mediæval plagues of Europe in deadliness. The terrible ravages caused by the introduction of measles into the Fiji Islands, a few years ago, will probably be fresh in the recollection of most of us.

My aim and ambition in writing this paper has been to send any readers, who have been interested, straight to the original authorities I have consulted, with the hope that they may therein find the information and the keen interest I have found. My apology for venturing to deal with subjects of which I have no experimental knowledge, must be made in Professor Huxley's words, on quitting the chair of the Royal Society:—"The man who works away at one corner of nature, shutting his eyes to all the rest, diminishes his chance of seeing what is to be seen in that corner. *That which the investigator perceives depends much more on what lies behind his sense-organs, than on the object in front of them.*" Here comes in the function of the person who assiduously collects and arranges the facts discovered by others. The writer of the "History of Astronomy in the XIX. Century" has probably made no astronomical discoveries herself. But what services she has rendered in her clear account of the enormous progress of astronomical science! Again, the world made little progress—indeed, had a way of constantly going back—whilst the wise men kept their wisdom to themselves, despising the vulgar herd of mortals. Knowledge, if it is to be of real service in eradicating ignorance and superstition, must be made clear and plain to the many. Darwin had the extraordinary genius and patience, not only to make more original observations than perhaps any other

man has done, but also to make the result of his investigations clear and plain to any person of ordinary intelligence.

But many original observers are unable to do this. Each works at his speciality as Oliver Wendell Holmes' immortal "Scarabee," worked at the "*larva of Meloæ*," and they are hardly aware of the magnitude of the coral reef they have been building. Hundreds and thousands of original workers are carrying on their investigations, yet one may search the leading periodicals in vain for any account of the results they have accomplished, probably because some stigma is supposed to attach to the fact of writing upon science without original investigation. Yet we do not say that only generals who have won battles, and politicians who have led senates, must write about history; we own that the historian has his special work, his peculiar talent. It is time, too, that Natural Science should have her historians; the glorious work she has done and is doing for men, should be proclaimed, not buried in the pages of scientific journals, to be read only by specialists.

THE CHAMELEON.—The colour of its skin is changed by virtue of the action of the nervous system on certain little vesicles containing pigment, which are in abundance on its surface. These contract when the nerves are excited, and thus squeeze out into a deeper portion of the skin the contained pigment.

THE NATURE OF DIATOMS.—These curiously beautiful microscopic objects can be found in the mud at the bottom of all pools of water. They were formerly regarded as animals, but are now classed among plants. Professor W. Mattieu Williams discovered their vegetable character thirty years ago by an observation which amounted to a demonstration. The white quartz pebbles in his aquarium became coated with a brown growth, caused by the development of these organisms, and at the same time evolved bubbles of gas. In the course of a few days, he found an inch of the vertical space of the test-tube, which he fixed to catch it, filled with the gas, and it was proved, by burning wood and other experiments, to be nearly all oxygen. Animals expire carbonic acid, plants expire oxygen. Therefore, diatoms are plants.

The Development and Life-History of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part I.

Plates I and II.

FOR some few years past it has been my custom during the spring time to devote a certain amount of attention to the development of the frog, obtaining for this purpose the spawn in as early a stage as possible, and keeping it under various conditions, so as to watch, with the unaided eye, as well as by means of the microscope and chemical balance, the various changes which the animal undergoes during its metamorphoses.

Although most of our best physiologists have written on the same subject, there seems on several points, and especially as to the nature of the food of the tadpole, a great divergence of opinion, some averring that it feeds on vegetable diet, whilst others are equally certain that it eats animal food.

Buckland, in his "Curiosities of Natural History," states that tadpoles eat both decaying animal and vegetable matters, in addition to being cannibals and eating each other. His words are well worth quoting:—"In the horse-pond were many tadpoles hustling and squeezing each other in their anxiety to get a dead kitten. And why should they not fight for good places? The dead kitten is to them what a turtle dinner is to the city folks; each duly appreciated by the rightful customers. But supposing there happen to be no dead kitten or decayed vegetable matter in the pond, what will the poor things get to eat? Why, they will do what the New Zealanders have done before them—viz., ate up every specimen of the Dinornis they could find on the islands, and then they set to work and ate up each other; so do the tadpoles." There is this difference, however, between the New Zealanders and the tadpole, that whereas the former killed his brother previously to breakfasting off him, the tadpole waits till he is dead before he commences to make his meal.

Huxley takes the opposite view. In the "Course of Practical

Biology," by Huxley and Martin, it is stated, p. 163, that "the animal (tadpole) crops the aquatic plants on which it lives by means of the horny plates with which its jaws are provided." Again, p. 164:—"The labial membrane and the horny armature of the mouth disappear, while teeth are developed in the upper jaw on the vomers; the intestine becomes less and less coiled, as, not growing at the same rate as the body, it becomes relatively shorter, and the animal gradually changes its diet from vegetable to animal matters, the perfect frog being insectivorous. This statement appears to be that generally adopted as fact at the present day, and it was in hopes of throwing some light on these apparently contradictory statements that my observations and experiments were first commenced.

The ova or frog-spawn is deposited in water early in the year. From the first or second week in February to the second week in March, according to the season, the male and female frogs repair to any fairly shallow, stagnant, or semi-stagnant pool, and there the spawn is deposited in large masses, fertilisation taking place as the ova are being deposited in the water. When we consider the immense numbers of ova deposited by one female, and that each egg is surrounded by a membrane which rapidly swells when it touches the water into a semi-gelatinous covering, it appears astonishing that nearly every egg becomes fertilised. Out of a mass which, when fully swollen by absorption of water, measures from six to nine inches in diameter and contains hundreds of eggs, not more than ten or twelve eggs will remain undeveloped. The further development of the egg is, however, much dependent on temperature. During the present season (1887), thousands around Bath were killed by the severe cold, which occurred within a few days of spawning.

The eggs were laid in some of the ponds this year about February 27th. Cold weather set in within a day or two, and from March 12th to March 21st intense frost and deep snow prevailed, so that after the snow had disappeared masses of dead spawn were taken from the same pond as that from which some hundreds of tadpoles had by this time developed from the spawn, which had been kept in a room at a minimum temperature of 40° F. and a maximum of 55° F.

It is not my intention to give any account of the development of the egg from its earliest stages, but thinking that a comparison of its structure in a median stage with that when newly laid might be interesting, a frog was killed in September, 1886, and sections made of the ova then contained in the ovary. The ovum at this date consisted of a nucleus surrounded by a thick follicle enclosed in a layer of dark pigment (Plate I., Fig. 1). The follicle consists of masses of oval granules. The nucleus is pear-shaped, and consists of an undifferentiated mass of protoplasm, which, under the treatment employed to obtain sections, frequently had a semi-granular appearance.

At this point it would seem well to mention that the whole of the sections spoken of in these papers, and of which diagrams will be given, were prepared by gradual hardening in successive strengths of spirit of 10 degrees, commencing with 20 degrees and ending with absolute alcohol, next immersion in oil of lavender, and lastly digesting at a temperature of 40 degrees C. for some hours in a bath of soft paraffin.

The nucleus at the date mentioned was not truly central, but very nearly so, and the whole ovum, from pressure of neighbouring ova, was distinctly angular, and indeed roughly triangular or pentagonal, no two having exactly a similar shape. Plate I., Fig. 1, A, B, C, gives an idea of their appearance, showing—(1) The pigment layer, *e*; (2) The thick layer, composed of oval granules, *g*; (3) the pear-shaped nucleus, *n*, which is nearly circular, as seen in transverse section.

When the ovum is first deposited, it consists of a dark ball, the embryo, about the 1/14th of an inch (2 millimeters) in diameter, enclosed in a jelly-like envelope, which to the eye appears perfectly homogeneous, but if placed in dilute acetic acid (2 per cent.) is seen to divide into two concentric layers, the inner one distinctly marked off from the outer by its pale yellowish tint and an apparent investing membrane.

This is sometimes called the albuminous, but, more frequently, the gelatinous envelope. An analysis of it made on March 7th, just a week after deposition, showed that it was neither albumen nor gelatine, but a substance which in its chemical characters partakes rather of the nature of chondrin, differing, however, from

that substance in not being converted into gelatine upon prolonged boiling. That, as a whole, it is not albumen is shown by its not being coagulated by heat nor precipitated by any of the substances which react upon albumen. The only portion of the capsule which corresponded in any of its reactions to albumen was the investing membrane of the inner capsule, which was rendered opaque, both by acetic acid and by mercuric chloride. The transparent envelope may be completely evaporated to dryness over a water-bath without coagulating, but is dehydrated and gradually rendered opaque by 92 per cent. alcohol. Boiled with caustic potash, a turbid solution is obtained which is rendered perfectly clear on neutralisation with acetic acid. Tannin has no action upon it, showing it not to be gelatine. Fehling's sugar-test does not reduce it, which proves it not to be a glucoside.

Its specific gravity was identical with that of water, the number actually obtained being 999·6 instead of 1000. It appears to absorb water for a long time after deposition, but at the period when analysed contained—

Water	99·49
Solids	·51
	100·00

This solid matter was transparent and perfectly hard and horny; indeed, almost glassy. A further analysis showed that it contained—

Mineral matter	24·50
Yellowish, oily fat, soluble in ether ...	·07
Organic matter, insoluble in alcohol ...	75·43
	100·00

From its peculiar chemical composition, it would seem that some special name ought to be given to this envelope, and I would suggest *Batrachin* as applicable, in order to distinguish it both from gelatine and chondrin.

The ovum after fertilisation rapidly undergoes a series of divisions, and after a short time is seen to consist of a somewhat mulberry-shaped mass, dark on the upper and light on the under side. A section of this—taken on February 28th, when probably

about one day old—is seen, in Plate I., Fig. 2, A and B, to consist of an undifferentiated yelk mass forming the body of the egg, surrounded by a dark layer of cells, the epiblast, under which we have a layer of larger cells, called the hypoblast. From the epiblast it will be seen in future plates that the epidermis, the nervous system, and most of the organs of special sense, are produced, whilst the hypoblast forms the whole of the epithelial lining of the alimentary canal, with its glands, excepting the lips and anus, which, like the external skin, are formed from epiblast. These two layers are well seen in Plate I., Fig. 3, where the epiblast is seen as a dark line of cells, the hypoblast consisting of a looser texture below. At the light pole of this figure may be seen a row of nucleated cells, which are well defined and marked off from the great body of non-nucleated cells, at this time forming the bulk of the yelk mass. It is from the different growth ot the nucleus in the cells that the distinctive character of each kind of tissue may be traced.

The epiblast soon spreads over the whole surface, with the exception of a small hole called the blastopore, through which an invagination of the epiblast occurs, and after this has gone on for some time, a flattening of the dark pole takes place (Plate I., Figs. 4, 5, and 6), and a delicate layer of cells, called the mesoblast (Plate II., Figs. 1, 2, 3, 4, etc.) forms between the epiblast and hypoblast. This mesoblast, although barely visible at first, is yet an extremely important part of the structure, as in the course of development it forms the bones, muscles, connective tissues, and blood-vessels.

The flattening of the dark pole was first observed on March 2nd, the third or fourth day after deposition. This flat spot soon deepened down into a curve, the outer rim at the same time rising up, forming a decided ridge or cornua, the sides of which, gradually approaching each other, produce a medullary groove, below which the most interesting and extensive modifications and re-arrangement of the three layers of hypoblast, mesoblast, and epiblast are occurring. These will be treated in a future paper.

EXPLANATION OF PLATES I. & II.

Plate I.

Fig. 1.—A.—Unfertilised ova, Sept., 1886, nucleus extracted.
B.—Ditto, nucleus in *sitû*.
C.—Nucleus extracted from A.
e, dark external envelope ; *g*., granular mass ; *n*., nucleus.

,, 2.—A.—Fertilised ovum, Feb. 27, 1887, light pole.
B.—Ditto, ditto, dark pole.
C.—Nucleated cell. × 125.
D.—Non-nucleated cell, × 125.

,, 3.—Fertilised ovum, March 3, 1887, × 50 ; showing *ep*., epiblast ; *hy*., hypoblast, forming under it.

,, 4.—Section from another egg, same date, × 25, showing *e*., transparent envelope formed of three layers ; *hy*., hypoblast ; *ep*., epiblast ; *md.g*., medullary groove.

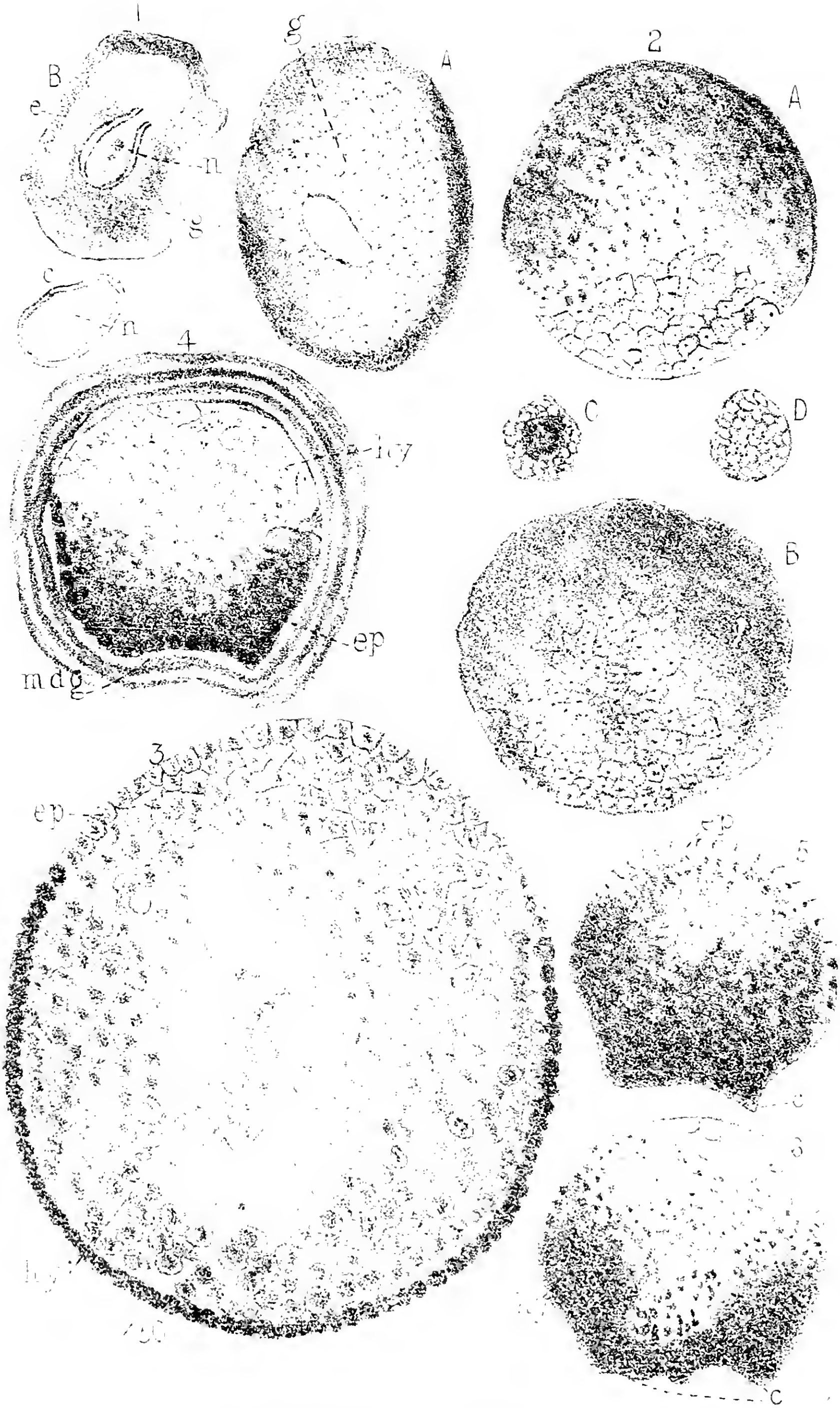
,, 5 and 6.—Two sections taken from one egg, March 4, in which the medullary plate and cornua are seen forming more completely *ep*., epiblast ; *hy*., hypoblast ; *c*., cornua.

Plate II.

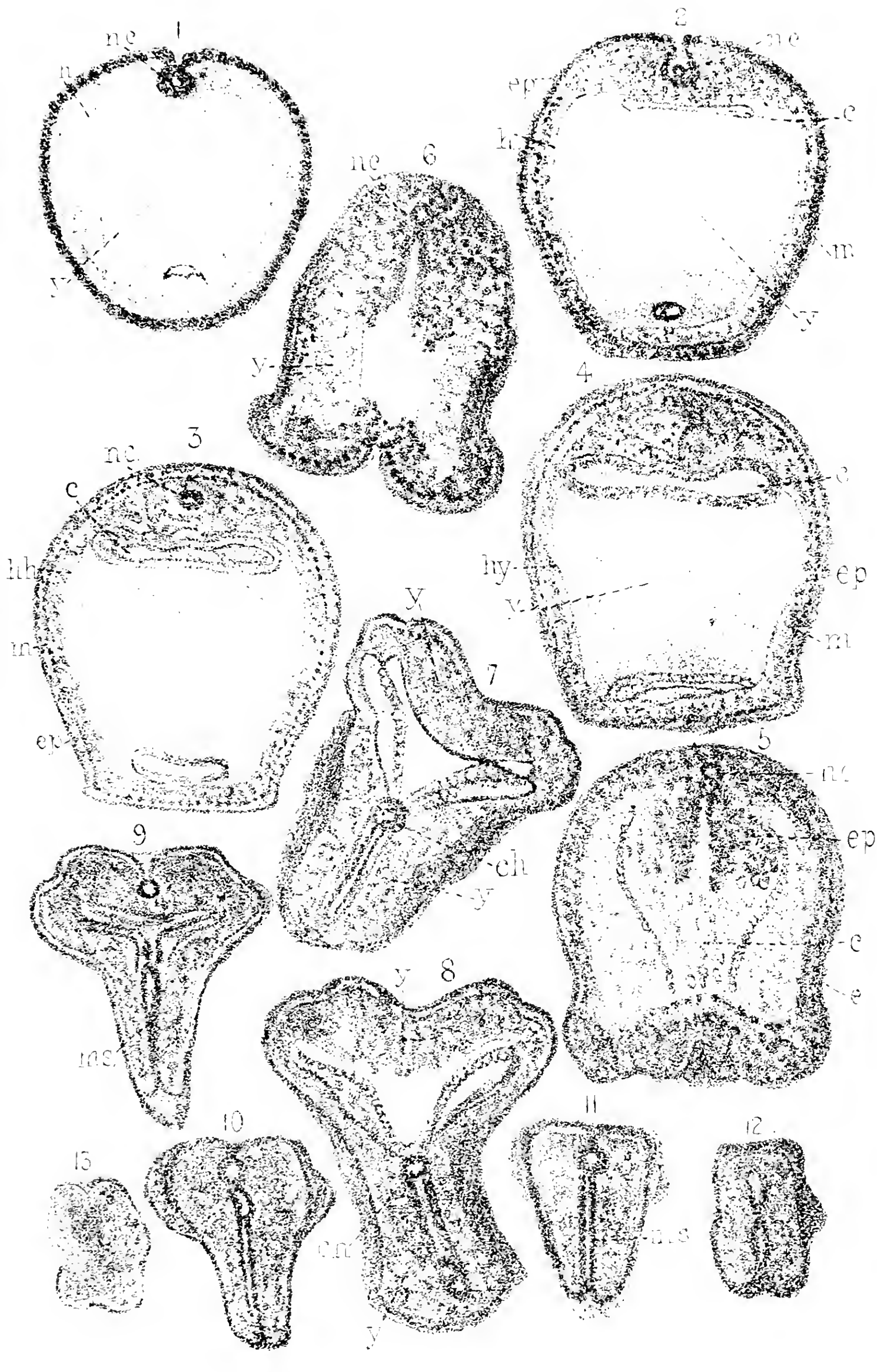
Figs. 1—13.—Thirteen sections cut from one egg, March 5, and follow in rotation according to the numbers. *ms*., mesenteron ; *nc*., notochord ; *ep*., epiblast ; *hy*., hypoblast ; *m*., mesoblast; *y*, yelk mass ; *c*., body cavity.

The Use of Pearl-Shells.—The pearl-shells shipped from Australia to the United States and Europe, are used principally for the manufacture of knife-handles, shirt-buttons, etc. Considerable quantities are also used for papier-maché and other ornamental work. The pearl buttons, shirt-studs, etc., now made in the United States are said to be the best and cheapest in the world, a fact due in great measure to the care in selecting the material, and to the improved methods of cutting.—*Bull., U.S., Fish. Comm.*

The Manchester Microscopical Society.—In the report of this Society, in our October issue, we should have stated that Mr. J. L. W. Miles was President in 1886, and that the President for 1887 is Professor A. Milnes Marshall, M.D., M.A., D.Sc., F.R.S., F.R.M.S., etc.



Development of the Tadpole.



Development of the Tadpole.

The Microscope and how to use it.

By V. A. Latham, F.R.M.S.

Part XIII.—Cements and Useful Recipes.

THE chief cements in microscopical work are gold-size, sealing-wax varnish, solution of shellac, solution of asphalt, marine glue, and Canada balsam.

Gold-Size.—Prepared by melting together gum animi, boiled in linseed oil, red lead, litharge, sulphate of zinc, and turpentine. Take 25 parts of linseed oil, boil with one part of red lead, and a third part as much umber, for three hours. The clear fluid is poured off and mixed with equal parts of white lead and yellow ochre, which have been previously well pounded. This is to be added in small successive portions and well mixed. The whole is then again to be well boiled, and the clear fluid poured off for use. The *older* the cement the better it is. This cement may be bought ready for use.

Sealing-Wax.—Prepare by dissolving the very best powdered sealing-wax in fairly strong alcohol with a gentle heat. It is apt to dry rather brittle, but forms a good varnish for the last coat.

Shellac is made by dissolving powdered shellac in spirit of wine. Shake the bottle frequently until a thick solution is obtained.

Bell's Cement.—I believe this was originally suggested by Mr. Tomes. It is sold by Messrs. Bell, chemists, Oxford Street. I do not know the composition, but think it contains shellac and gold-size.

Brunswick Black.—Take of india-rubber, cut into very small pieces, ½ drachm; asphaltum, 4 oz.; *Mineral* Naphtha, 10 oz. Dissolve the india-rubber in the naphtha, then add the asphaltum; if necessary, heat must be employed. Some friends say they cannot always succeed with this. I believe the faults are—either the rubber or asphaltum has *not* been *pure*, or that the naphtha used has been *wood* instead of *mineral*.

Common Brunswick Black is made by melting one pound of asphaltum; then adding half a pound of linseed oil and a quart

of oil of turpentine. The best black is made by boiling together a quarter of a pound of foreign asphaltum and 4¼ ozs. of linseed oil, which has been previously boiled with ½ oz. of litharge until quite stringy. The mass is then mixed with half a pint of oil of turpentine, or as much as may be required to make it of a proper consistency. It is often improved by being thickened with lamp-black. Dr. Eulenstein, of Stuttgart, finds that equal parts of Brunswick black and gold-size, with a very little Canada balsam, form a very lasting cement. I find a good substitute for Brunswick black in the "liquid stove-polish."

Electrical Cement.—Melt together five parts of resin, one of bees'-wax, and one of red ochre. It must be used whilst hot, and can be readily moulded into any form. It is often employed in making shallow cells for liquid mounts.

Mask-Lac.—This is a very good quick-drying cement, especially for wet preparations, and also as a coating for specimens mounted in Canada balsam or copal. The variety of lac is designated as No. 3 at Beseler's lac factory in Berlin (Schützen Strasse, No. 66).

Shellac and Aniline (Thiersch).—After the specimens have been mounted in Canada balsam, surround with a border of Canada balsam dissolved in chloroform. After the third or fourth day apply a final coating, consisting of a thick varnish of shellac, coloured with a filtered, concentrated solution of aniline blue or gamboge in absolute alcohol. Finally, about a scruple of castor-oil is to be added to each ounce of the mixture, and after some further evaporation is to be preserved in a well-closed vessel. If after a time it becomes too concentrated, a few drops of absolute alcohol may be added. The varnish is to be applied to the border of the balsam with a brush. It soon becomes hard and forms an elegant and hermetic covering and finishing cement.

Dr. Bastian's Cement.—This is much used in Germany, and is the best cement for liquid cells. It is made by adding a considerable quantity of nitrate of bismuth to a solution of gum-mastic in chloroform. It may be procured at almost any optician's.

An Extra-Adhesive Gum.—Dissolve 2 drachms of isinglass in 4 oz. of distilled vinegar; add as much gum arabic as will give it the required consistency. This keeps well, but is apt to become

thinner, when a little more gum may be added.

Marine Glue (Dr. Goadby).—Dissolve, separately, equal parts of shellac and india-rubber in coal or mineral naphtha, and afterwards mixing the solutions thoroughly with heat. Marine glue is dissolved by naphtha, ether, or a solution of potash.

Cement for attaching Gutta Percha or India-rubber to Glass Slides(Hartin).—One part of gutta percha is to be cut into very small pieces, and stirred at a gentle heat with 15 parts of oil of turpentine. The gritty, insoluble matter, which is always contained, is to be separated by straining through a linen cloth, and then one part of shellac is to be added to the solution, kept at a gentle heat, and occasionally stirred. The mixture is to be kept hot until a drop, when allowed to fall upon a cool surface, becomes tolerably hard. When required for use, the mixture is to be heated, and a small quantity placed upon the slide upon which the cell is to be fixed. The slide itself is then to be heated.

Dammar.—A good ringing cement is dammar dissolved in chloroform, because if inclined to run under the cover it will readily mix with the mounting materials. In drying, the dammar shrinks, and thus renders it necessary to apply another coat in a few hours' time.

A good and inexpensive Cement for Glycerine Mounts, etc.—Dissolve 10 grs. of gum-ammoniac in 1 oz. of acetic acid (No. 8); then add to this solution 2 drachms of Cox's gelatine. It flows easily from the brush, and is waterproof, though rendered more so if subsequently brushed over with a solution of 10 grs. of bichromate of potash in 1 oz. of water. This cement is especially recommended on account of its power of adhesion to glass, even should there be a little glycerine left behind on the cover. After the gelatine ring is dry, any cement may be used.

Ground Borax, mixed with plaster of Paris, makes a good cement for large cells, etc.

French Cement.—A quantity of india-rubber scraps are carefully melted over a clear fire in a covered iron pot, but they must not be permitted to catch fire. When the mass is quite fluid, lime in a perfectly fine powder, having been slacked by exposure to the air, is to be added in small quantities at a time, the mixture being well stirred. When moderately thick, it is

removed from the fire and well beaten in a mortar and moulded in the hands until of the consistence of putty. It may then be coloured with vermilion or other colours. This cement is quite safe for mounting large and thick objects in fluid, as it rarely gets hard.

Caoutchouc Cement.—Caoutchouc, cut small, ½ oz.; mineral naphtha, 1 pint. Dissolve with heat, and add shellac, ½ oz. This cement requires great care in making.

Resin and Balsam Cement.—Resin, 2½ oz.; bees'-wax, ½ oz.; Canada balsam, 1 drachm. Dissolve with heat and mix. When wanted for use, it must be rendered mouldable by the action of heat. It is a strong cement.

Good Black Varnish.—Mix well in a mortar some lamp-black and gold-size. It makes a good tough finishing varnish. Gold-size, when added to Brunswick black, renders it less liable to crack. It is better to keep nearly all the cements some time before use.

Mastic and Bismuth.—Dissolve gum mastic in chloroform, and thicken with nitrate of bismuth. The solution of mastic should be nearly saturated.

Kitton's Cement* is made of equal parts of white lead, red lead, and litharge, all in powder. Grind together with a little turpentine until thoroughly incorporated, and then mix with gold-size. The mixture should be thin enough to use with a brush. In using, one coat should be allowed to dry before applying another. No more cement should be mixed with the gold-size than is required for immediate use, as it sets quickly and becomes unworkable. For balsam or glycerine-jelly mounts almost any varnish will do, but for fluids, glycerine, etc., it is necessary to have one tough, which will prevent leakage.

Liquid Glue.—Dissolve shellac in wood naphtha at a very low temperature, until the mixture is of the required consistency. It makes a very brittle varnish, but is improved by the addition of a little glycerine and makes very good cells.

Guaiacum Varnish.—Gum guaiacum, 2 ounces; shellac, 2 ounces; methylated spirit, 10 ounces. Powder the guaiacum and dissolve it in the spirit, filter and then add the shellac. Keep the

* *Monthly Microscopical Journal*, Oct., 1876.

whole in a jar, surrounded by warm water, until it dissolves.

Matt Varnish.—Take gum mastic, 40 grs.; gum sandarac, 160 grs.; methylated ether, 4 oz.; benzole, 1½ oz. Dissolve the gums in the fluids and triturate in a mortar.

Black Matt Varnish.—Gum mastic, 50 grs.; gum sandarac, 200 grs.; methylated ether, 1½ oz.; benzole, ½ oz. Dissolve the gums in the fluids and triturate in a mortar, with sufficient lamp-black of finest quality.

French Polish.—Shellac, 3 oz.; gum sandarac, ½ oz.; methylated spirit, 1 pint. French polish is sometimes coloured with gum-dragon, etc.

Dammar and Benzole.—Gum dammar, 1 oz.; benzole, 2 oz.

Mastic and Benzole.—Gum mastic, 4 oz.; benzole, 3 oz.

Canada Balsam Varnish (for rendering ground-glass transparent).—Take 4 oz. of Canada balsam and bake in a cool oven till quite brittle. When cooled, dissolve this in 12 oz. of benzole, in which ½ oz. of mastic has been previously dissolved.

Brown Varnish.—Pure india-rubber, 20 grs.; bisulphide of carbon, *q.s.*; shellac, 2 drachms; methylated spirit, 8 oz. Dissolve the india-rubber in the smallest possible quantity of bisulphide of carbon, and add this to the alcohol in such a manner that the whole is mixed without the formation of clots. Now add the shellac, and place the jar containing the mixture in boiling water, until the whole of the shellac is dissolved and the smell of the bisulphide has disappeared.

Litharge and Glycerine.—If dry sifted litharge powder is mixed with glycerine, it forms a cement which hardens rapidly in air and water. It bears 275° C., is very resistant to re-agents, and adhesive to all materials, articles to be cemented being previously moistened with glycerine. (J. C. Douglas.)

Copal Varnish (Winsor and Newton's) may be made as a substitute for Canada balsam by evaporating it gently over a spirit-lamp in a suitable vessel until nearly all the solvent (turpentine) is driven off and the residue becomes viscid. To this, while warm, pure benzole may be added, until it is considered to be sufficiently liquid. It may then be used like fluid balsam, with or without heat. It is absolutely necessary to use pure benzole.

American Cement (Dr. Hunt).—Take some *zinc white*, as sold for painters' use, drain off the oil, and mix with Canada balsam, dissolved very thin with chloroform. If it does not flow freely from the brush, add a little turpentine. The mixture should be about the thickness of cream and kept in a bottle with a glass cap. Ring the slide with the cement, and paint on it with artists' oil colours, thinned if necessary with turpentine, and when dry varnish with very dilute balsam, to give it a gloss.

Liquid Cement.—Compound tragacanth powder and powdered gum acacia from any chemist, and if these are well mixed in equal parts and moistened according to requirements at the time with dilute acetic acid, or, if the colour be not of any importance, with ordinary vinegar, a strong and lasting cement will be obtained.

White Hard Varnish consists of gum sandarac dissolved in spirits of wine, and mixed with turpentine varnish.

Zinc White is composed of benzole, 8 parts; gum dammar, 8 parts; oxide of zinc, 1 part. Mix the gum dammar and the benzole, filter through cotton wadding, after which mix in the oxide of zinc in a mortar, and again filter through the wadding.

Gelatine Cement.—For sections mounted in glycerine, undoubtedly the best method is Dr. Marsh's,* who suggests gelatine solution as a cement for first fixing the slide. The reason for this is that gelatine readily mixes with the glycerine in its immediate neighbourhood. He prepares the solution by placing a small quantity of gelatine in a narrow glass beaker, covering it with water, and allowing the gelatine to take up as much of the water as it will. Any superfluous water is poured off, mixture heated, and three or four drops of creosote are added to each ounce of the fluid. Keep in a small bottle, and each time that the mixture is needed it is "rendered fluid by immersing the bottle containing it in a cup of warm water." The slide must be perfectly freed from glycerine by the aid of a camel-hair pencil and a damp cloth. A ring of the gelatine fluid is painted round the edge of the cover-glass. As soon as this is set, paint it over "with a solution of bichromate of potash, made by dissolving 10 grs. of that

* Dr. S. Marsh's "Section-Cutting, etc.," 2nd edition.

salt in 1 oz. of distilled water." He recommends that "this application of potash should be made in the daytime, as the action of daylight upon it, in conjunction with the gelatine, is to render the latter insoluble in water." Wash well in methylated spirit, to remove all the glycerine, and then run on a ring of zinc white, which may be repeated until a good firm ring is made. To keep the brushes clean, I always have a little phial of turpentine or benzole for zinc white, and warm water for the size, glue, or gelatine. When zinc white becomes too thick to run readily, dilute with benzole, but *only when absolutely necessary.*

Dammar Cement.—Dissolve gum dammar in benzole, and add one-third gold-size. It dries quickly, and is preferably used as a first coat for fixing the cover-glass when glycerine is used for mounting. If the *square covers* are employed, they may be fixed by a simple method, much in vogue in Germany. A thin wax taper is to be lighted, and being partially inverted for a few seconds, the wax surrounding the wick will become melted. After the slide has been freed from excess of glycerine, a drop of this heated wax is allowed to fall upon each corner of the cover, and a line of the melted wax run along the margins of the cover between these points so as to perfectly surround it. If a good coat of white zinc cement be subsequently laid over the wax, a very durable and not unornamental line of union will have been formed.

Coloured Cement.—Carefully evaporate shellac-varnish to consistence of thin mucilage, and colour with a filtered, concentrated solution of aniline blue or gamboge in absolute alcohol. Finally, about a scruple of castor-oil is to be added to each ounce of the mixture, and, after some further evaporation, it is to be preserved in a well-closed vessel. If necessary, it may after a time be diluted by a few drops of absolute alcohol.

Gum-Water, thickened with gilder's whiting until as thick as treacle ; to each quarter of an ounce add two drops of glycerine.

Cement for Fixing Metals to Glass or Earthenware.—Mix alum and plaster of Paris (finest kind) with water to a liquid state or to a convenient paste. It forms an excellent cement for many purposes, and resists the action of water for a considerable time.

Certain precautions are necessary to be observed in using varnishing fluid or glycerine preparations:—1.—Use no more glycerine or fluid than is just necessary to fill up the space beneath the cover. 2.—If the medium should escape beyond the cover-glass, soak it up with a piece of blotting-paper, and be careful not to press the cover, or the cement will run into the cell.

Many students find the white zinc has run under the covers in course of time. The only remedy I believe is to wash off and clean with benzole; then slightly warm the slide and lift off the cover-glass. I believe it results from not using a varnish previous to the white zinc. A friend of mine recommends two coats of "painters' knotting" before laying on the coloured rings, and has seldom a slide spoiled.

Smith's New Cement.—This is especially adapted for slides mounted in the stannous chloride mounting medium. It is made by diluting a somewhat thick shellac cement with benzole, and adding sufficient litharge to give a consistency about the same as the white zinc cement. It dries very quickly, forms very hard rings, and it becomes dark-brown on exposure. A thin coat should first be applied, and when this is well dried add as many more as required.

Strong Cements for attaching Brass Cells to Glass Slides.—(1) Carbonate of lead, ½ oz.; red oxide of lead, ½ oz.; litharge, 1½ oz. Grind thoroughly together in a mortar. Stir some of this into enough gold-size to make it work stiffly. If too much adheres to the work, turn it off on turn-table when a little set. (2) Best quality gum-arabic. Dissolve in cider-vinegar; add a little sugar.

Mucilage for Slide Labels.—Dissolve 2 oz. dextrine in 1 oz. acetic acid, diluted with 5 oz. water; when dissolved, add 1 oz. alcohol. This is the same as that used for postage-stamps.

Half-an-Hour at the Microscope, With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Onosma tauricus (Plate III., Figs. 1, 2, 3).—I am much obliged to our friend, J. Carpenter (p. 51), for his reference to the article on stellate hairs in *Science Gossip*. His description of the plant scarcely does justice to its merits. I call it a dainty little flower, which must now possess special interest to us as microscopists. It is scarcely necessary to apologise for introducing a figure from *The Botanic Garden*, Vol. II., No. 234. The name comes from the Greek οσμη (*osme*), smell or savour. "When the soil is very dry, and the situation sufficiently warm and sheltered to support it in health, this little plant (only three inches high) becomes desirable as an ornament to the flower-border." The preparation before us becomes an interesting companion to a specimen of the leaf mounted as an opaque object by another member. Examining the leaf with which we are now favoured, I should prefer it mounted in a cell deep enough to prevent disarrangement by pressure. We should then see its connection with *Lycopsis arvensis* (Fig. 5). In the latter there are large hairs seated on an expanded cellular base, having carbonate of lime in the cells. Both plants belong to the same natural order (BORAGINACEÆ). Now, if each of the basal cells were produced into a spine, the conditions presented by *Onosma* would be found. Imagine the basal cells to communicate with the central spine, and to secrete a highly irritating fluid, and we should have what is found in the stings of nettles (Fig. 4) and the loasas.

Scales from Bracken (Plate III., Figs. 6 and 7) form a charming object. "A thing of beauty is a joy for ever." With this graceful fern growing in our hedges, and over acres of common around, I yet was unaware of the beautiful scale it bears, the technical name for which is *ramenta* (chaffy scales). I must ask on what part of the plant they are situated. Seeking them lately, I could only get on the young, still buried shoots, long jointed hairs (Fig. 7), which form a thick felted covering, which wraps it up like a warm blanket against the frost.

Fern (oblique section), probably Bracken; shows well the structure of the "*Scalariform vessels*" so characteristic of ferns. Henfrey says, "These, so-called from the ladder-like markings, are a very regular form of the reticulated type" (of ducts); "this regularity appearing to depend however upon the relation between the markings of the adjacent organs. . . . In the scalariform ducts a spiral fibrous deposit is conjoined into a network by

vertical fibres placed opposite the intercellular passages or the meeting angles of contiguous cells or ducts, leaving regular slit-like spaces opposite the cavities of the adjacent cells. This form is especially characteristic of the Ferns; but it occurs also commonly in the Dicotyledons in a less regular form, passing quite insensibly into PITTED DUCTS, as in the wood of *Eryngium maritimum*; the scalariform vessels of Ferns are often slightly unrollable."—(*Micro. Dict.*, *2nd ed.*, *p. 640*).

Ducts very similar are found in the Wheat Root, in the stem of Vegetable Marrow, and elsewhere; indeed, I have often been struck with the close similarity in structure between the ducts of some common plants and those generally considered peculiar to ferns.

Sections of Sugar-Cane (Plate IV., Figs. 1 and 2).—The transverse section is more satisfactory than the longitudinal, which would have been better if put in glycerine. The type of structure is very interesting, as connecting our ordinary fistulose grasses with the compound structure met with in palms. There are in the sugar-cane smaller ducts having a structure I have not met with elsewhere—viz., distant annuli with the walls of the vessels closely porose. These should be exhibited, as well as the ectoderm, the structure of which is highly characteristic. Pieces of sugar-cane in the fresh state are not unfrequently to be met with.

Periploca Græca, tr. sec. (Pl. V.).—The special feature of interest consists in the dark masses of inspissated proper juice. Lindley tells us that "the milk of *Periploca Græca* is very acrid, and has been employed by Orientals as a wolf-poison" (Lindley's "Vegetable Kingdom," p. 626). I do not know the plant, which belongs to the *Asclepiadaceæ*. This order contains the beautiful *Hoya carnosa* and the singular *Stapelias*, the odour of whose flowers is so fœtid that they are commonly known by the name of "carrion-flowers." Longitudinal sections showing the laticiferous vessels and the ducts are required to complete the information partially afforded by this specimen. In sections of the stem of white poppy, the dark inspissated juice (opium) may be seen, much as in the present slide.

Rhubarb, long. sec. (Plate IV., Fig. 3), showing spiral vessels and raphides *in situ* as an opaque object, was shown a short time ago, and excited much interest in those who had the pleasure of seeing it. Wishing to know more about it, I have ascertained that it was a piece of one of the dead, decaying leaf-stalks, which at the date of writing were to be obtained in plenty where the plant is cultivated. These are to be cut in short lengths, then made into thin slices, and slightly pressed. A slide so prepared should be in every cabinet.

Calyx of Deutzia gracilis (Pl. VI., Figs. 1, 2, and 3).—Sure, never were more lovely stars presented to us than these. The plant belongs to a very small natural order (*Philadelphaceæ*). Four species are cultivated in this country, all characterised by these lovely diamond-spangled stars. *D. scabra* is in common cultivation, "the rough leaves of which are used in Japan" (its native country) "by polishers" (Lindley's "Vegetable Kingdom," p. 750), like the stems of the "Dutch Rush" (*Equisetum hyemale*) with us. A lovely companion to this slide may be obtained from the young shoots of this plant (*D. scabra*), mounted just as they are. Here the stars shine out from a pinky purple ground.

Pollen of Shamrock (Pl. VI., Figs. 4 and 5).—"What is the shamrock? the national badge of Ould Erin." This question has given rise to much discussion. By my valued friend, the late Robert Ball, of Trinity College, Dublin, I was informed that the educated Irish consider *Oxalis acetosella* to be the true plant, whilst the common people take the hop-trefoil (*Medicago lupulina*) for it, and have curious superstitions connected with finding four-leaved examples of it—perhaps on "St. Patrick's day in the morning." The general conclusion is that St. Patrick pointed his hearers for an illustration of the Trinity to the first trifoliate leaf to hand. If preaching in a wood, this might likely be the graceful sorrel; if in the meadows, then the trefoil. As it would be necessary to wait, at any rate, for flowers of *O. acetosella*, I have examined the pollen of *O. floribunda*, an almost perennially-blooming, indoor plant, with flowers of a most beautiful rose colour. Finding the pollen in the plant, with its elliptic outline, three deep longitudinal sulci, and punctato-reticulate surface, to agree with that in the slide before us, I think we may conclude that the pollen was from the wood-sorrel.

Egg of Bot-Fly (Pl. VI., Figs. 5—11).—With reference to H. E. Freeman's remarks (p. 51), the apparent "hole" in the egg of bot-fly is really a deep-rounded hollow; its use, I suspect, to be for attachment of a ligament of union between the lid and the body of the egg-shell. The presence of the basal membranous wings on the shell previous to hatching is a highly curious and suggestive fact. They are special modifications of the alæ on the eggs of the lesser house-fly (*Musca domestica*).

Stomach of Bee (Pl. VI., Fig. 12).—The distribution of the tracheæ to the stomach of bee depends for its value on the number, situation, size, and mode of arborescence. There is no spiral present in the very fine ramifications. A valuable paper on the anatomy of tracheæ in insects, by Sir John Lubbock, will be found in "Transactions of the Linnæan Society," also some useful notes by B. T. Lowne in his work on "The Blow-Fly."

Small Fly from Greenhouse is a homopteron. If there be four wings present, with two joints to each tarsus, it is a species of *Psylla;* if two wings, and one joint only in each tarsus, then it is a *Coccus*. Systematic descriptions of the insects in these genera are much required. Two species of *Psylla* may be readily procured for purposes of study in the summer:—One, *Psylla buxi* (whose history is traced by Reaumur, "Mémoires," Tom. III., Pl. XXIX., Fig. 1—16), causes the terminal shoots and young leaves of the box tree to assume the appearance of buds. The other inhabits the underside of leaves of the great nettle. Of the *Coccidæ*, the most accessible example is the "scale-insect" infesting leaves of the myrtle and oleander. Westwood (Intro. Mod. Class. Insects, II., pp. 434—450) should be consulted for a general view of the subject, and also from its giving references to authorities who have written in detail, with figures.

Sponge, a piece of.—The following particulars are wanting to make this specimen a satisfactory demonstration, or indeed of any value; it wants to be connected with other things of a similar kind. We should also be told its scientific name; in what direction the section has been made; and from what part, near the base of attachment, or the distant part of the sponge; its size and habitat (as fresh-water or marine). These particulars, if satisfactorily given, would impart real value to what otherwise is almost valueless.

Sand-Blast Cells promise to be a valuable addition to the means of the working microscopist. One of the most important questions in mounting at the present time is, *How to display objects without crushing*, readily, without loss of time involved in making, or the extra heavy weight of glass or tin cells. Large sizes will be required, and it will be an advantage to have the hollow not rounded, but in every part even with the surfaces of the slide.

Bacteria in Sea-Air.—Moureau and Miquel, as a result of their microscopical analyses of sea-air at various places, state that when the breezes come from the sea the air is almost free from bacteria. When 100 kilometres out at sea, the breezes coming from the shore are almost free from them, thus proving that the sea is an insurmountable barrier to contagion.

Selected Notes from the Society's Note-Books.

Onosma Cuticle, prepared for the polariscope (Pl. III., Figs. 1—5), is a very pleasing object with a 1-inch o.g., with blue selenite or dark ground. The plant is not much grown, the flowers being inconspicuous. A short account of the plant and stellate hairs will be found in *Science Gossip*, 1871, p. 83. If viewed as an opaque object, fresh leaves should be used, as the hairs shrivel to a certain extent, and most leaves deteriorate rapidly when mounted dry. J. CARPENTER.

Eggs of Bot-Fly.—I have obtained several species of gadfly this summer, and especially *Gasterophilus equi*, the bot-fly of the horse. I send some eggs of this fly taken from the body of the ♀, and these show the grooves and filaments for attachment to the hairs of the host in the *immature* egg. The cover is also remarkably distinct (Plate VI., Fig. 7), and there is a hole, perfectly distinct, well seen in some of those on the slide, into which a point on the cover probably fits, but I fail to see any corresponding projection on the cover. I have just succeeded in mounting an egg on the hair, showing the larva just emerging. The lines on the surface are much more distinct on deposited eggs. H. E. FREEMAN.

Scales of Pteris aquilina are very similar to some of those so numerous on the back of the frond of *Ceterach officinarum*, but the latter fern has circular scales mixed with the ovate ones.
H. F. PARSONS.

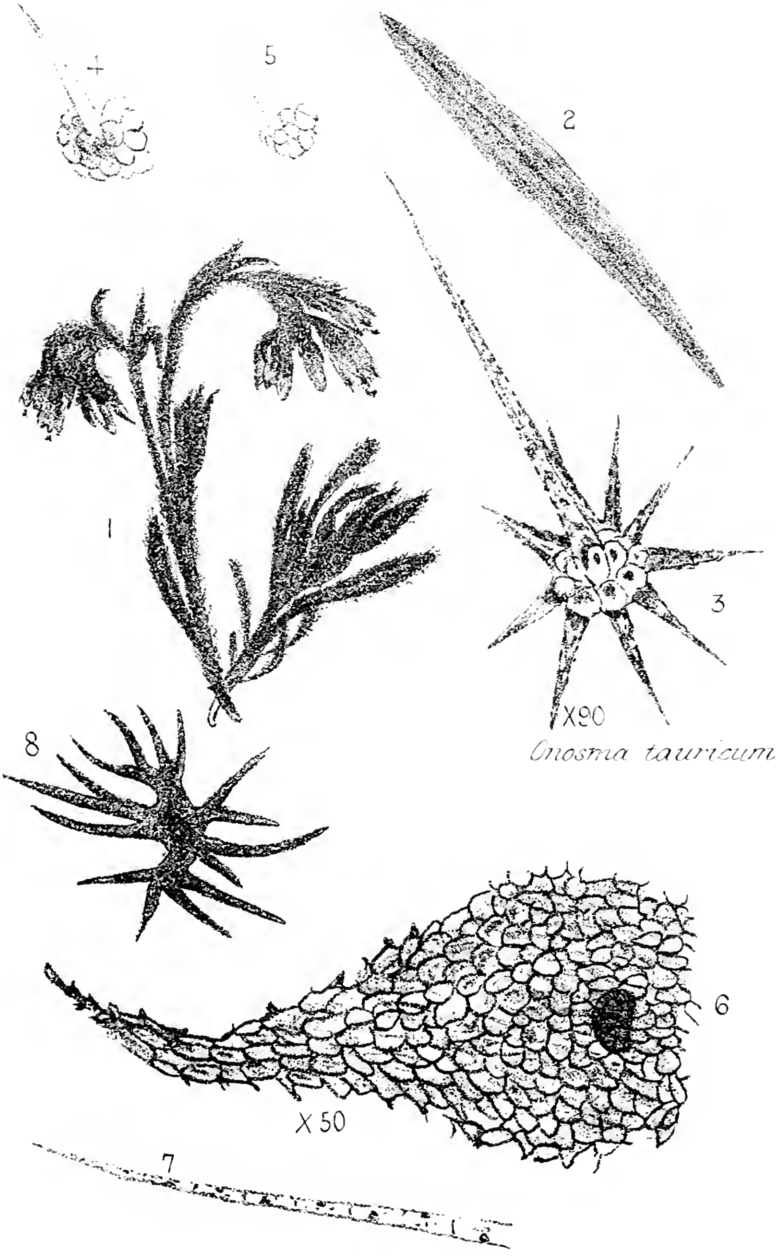
Section of Asparagus, to compare with section of sugar-cane (Plate IV.). The asparagus is, so far as I know, the only British plant, except the Butcher's Broom, whose stem exhibits the typical endogenous pattern. H. F. PARSONS.

Shamrock.—Although the Irish of the present day use the varieties of trefoil as the national emblem, the *Oxalis acetosella* agrees with the description of the plant mentioned by early writers, who state that it was eaten by the Irish and that it had a sour taste. The trefoils or clovers could not have been thus designated, as they do not answer the description, not being sour.
S. A. BRENAN.

Spinnerets of Spider to Mount.—Put the spider in liquor potassæ for one night, then cut off the spinnerets with sharp scissors, put then again in liquor potassæ, and they will come clean. Put them in glycerine and mount in jelly in a cell. W. LOCOCK.

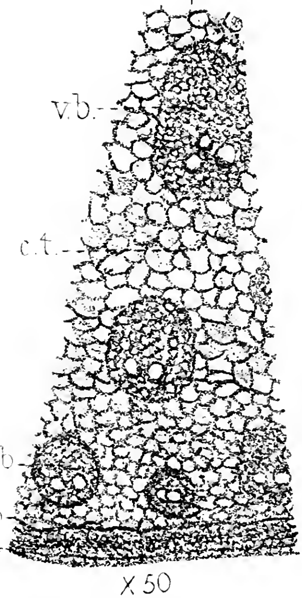
Sugar-Cane.—There are one or two points in Mr. West's description of the sugar-cane, upon which if I express a doubt, that doubt probably arises more from my own ignorance of the subject than from any inaccuracy on his part. On page 7 of an elementary treatise by Edward Smith, forming part of Orr's Circle of the Sciences, there occurs a description of the tissue called "sclerogen," accompanied by a figure illustrating its presence in the pith of the elder, from which, and indeed from the appearance of the slide under examination, I should infer that the markings seen on the cell-walls were rather the result of sclerogenous deposit than, as Mr. West observes, in the explanation to his plate (page 48 and Plate IV.), indicative of the presence of pores. Again, I have been hitherto under the impression that there was no such thing as a cambium layer in endogenous stems, at least in the situation where it is found in exogens, between the bark and the wood. Smith, at p. 87, says that the bark of endogens "cannot, in any normal instances, be readily separated from the stem, as may be readily seen by attempting to peel a cane. It does not naturally crack, as does the bark of our forest-trees, but is hard, dense, smooth, (usually) non-corrugated, unelastic, but slightly extensible, and is a permanent, unchanging structure"; and again, on p. 88, he says:—"It is the fashion to state that endogens have no bark, since *none is separable from the wood*, and that the cuticle is simply the hardened, exposed cells of the stem, with the ends of bundles of woody fibres intermixed." All this seems to me incompatible with the thick zone of bark represented by Mr. West's plate; still less do I understand the existence of an outer zone of growth, or cambium, in plants, which, as their name implies, increase from within—that is, by the passing down of new bundles of woody fibres from the leaves through the cellular matrix of the stem. A. HAMMOND.

Eggs of Bot-Fly (pp. 49 and 51).—May I suggest that the circular marks on this object, about which some discussion appears to have arisen, may be the micropyle, whereby the spermatic filaments gain access to the yolk. Notices of this micropyle appear in an article by Jabez Hogg on insect eggs in the *Intellectual Observer* for December, 1867; it is also mentioned in Lowne's "Anatomy of the Blow-Fly," pp. 114, 115. The wavy lines or ridges noticed by Mr. West I take to be indicative of a cellular structure in the chorion or eggshell. Such structure may be noticed in more insect-eggs, and is mentioned by both Hogg and Lowne. I have myself found it to assume a very curious form in the eggs of the great green grasshopper, *Acrida viridissima*. In this egg there is a strong chitinous covering surrounding the yolk, upon which, as upon a basement, an external layer of dumb-bell-



Scale from Pteris aquilina.

1



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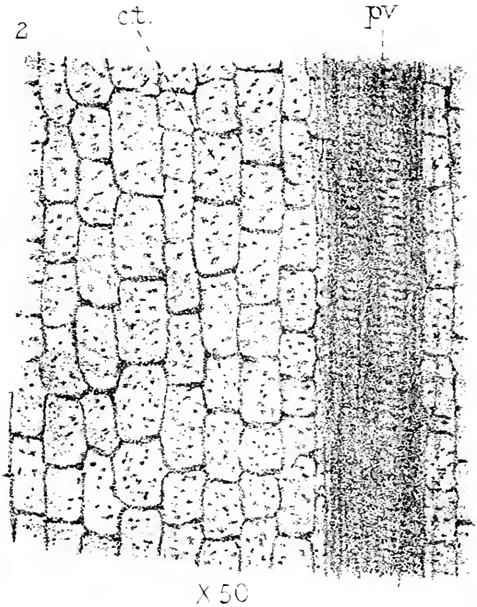
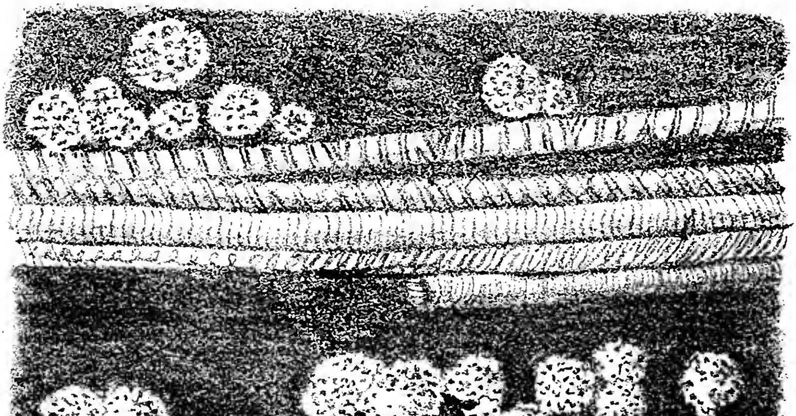


Stem of Sugar Cane.

3



Spiral Vessels and Raphides in Stem of Rhubarb.

shaped cells is found (see Plate VI., Fig. 12), the ends of which are hexagonal and fit closely together, forming two continuous surfaces, separated from each other by an intervening space, which is bridged over by the central narrow portions of the cells, as by so many pillars, like the blocks of coal which are left at intervals to support the roof of a coal-pit. A. HAMMOND.

Insect Dissections.—I have been asked by a friend to describe the manner in which I dissected some insect mounts which I lately sent round the Society. *Pro bono publico*, I will state that the apparatus I employ is of a very simple description, consisting of a few straight and bent needles, mounted in penholders, two pairs of curved forceps obtained at the opticians, and also two pairs of fine scissors, one bent in the plane of the blades, and another curved at right angles to it, an old plano-convex lens from a telescope mounted on the end of an arm, which projects from a sliding piece which slides on a wooden upright fixed on a stand, in the same manner as a bull's-eye condenser slides up and down on its perpendicular support; the whole made by a joiner. I employ a bull's-eye with the edge of the wick, and another condenser to collect the rays rendered parallel by the bull's-eye, thus getting a strong light. Use an old sardine-box for a dissecting trough, with a leaded cork to pin the subject to, the operation being all performed under water, with just sufficient to cover them; a minute knife extemporised by grinding down a packing-needle, and setting it in a penholder, is often convenient when a lancet is too large. The insects examined are mostly such as I have collected during the summer months and preserved in spirit. When the integument is to be studied, the "innards" should be dissolved out by soaking in potash and afterwards washed and brushed out. A. HAMMOND.

EXPLANATION OF PLATES III., IV., V., VI.

PLATE III.

Fig. 1.—*Onosma tauricum*. Drawn by Tuffen West.
,, 2.—Leaf of ditto, natural size.
,, 3.—Stellate hair from underside of leaf, seen as an opaque object, × 90. Drawn by John Carpenter.
,, 4.—Diagrammatic sketch of hair of Stinging Nettle.
,, 5.—Ditto hair of Lycopsis.
,, 6.—Scale from Bracken, *Pteris aquilina*, × 50.
,, 7.—Scale from young shoot of Bracken. Drawn by Tuffen West.
,, 8.—Scale from *Alyssum calycinum*. Drawn by W. H. Beeby.

PLATE IV.

Fig. 1.—Portion of a transverse section of stem of Sugar-Cane, × 50. *ecd.*, ectoderm, outer layer of cells having stomata or epidermis. Within this is the bark, between which and the woody

portion of the stem is the zone of growth—*cambium*—indicated by *cb.*; *v.b.*, *v.b.*, vascular bundles, porous and annular vessels embedded in a mass of wood-cells; *c.t.*, cellular tissue.

Fig. 2.—Portion of a longitudinal section; *c.t.*, cellular tissue, the elements of which are seen to be porous; *p.v.*, porous vessels, not very distinctly seen, owing to surrounding wood-cells.

,, 3.—Spiral vessels and raphides from stem of rhubarb, × 100.

PLATE V.

Transverse section of stem of *Periploca Græca*, × 50, showing to a certain extent the structure of the pith, *p.*; wood, *w.*; and bark, *b.*

The wood is seen to be lax, with very numerous large ducts, *d.d.*; from minute fragments to be seen here and there, these are evidently porous ducts. *c.b.* indicates the cambium layer, or common centre of growth for wood and bark, equivalent to the *basement membrane* in animal tissues; *h.h.*, bases of hairs arising from the ectoderm; *m.r.*, *m.r.*, medullary rays, very numerous and fine, whose purpose is to keep up the vital connection between the central structures and the seat of vital growth. These are seen to be continued, though in an imperfect form, into the bark. The black patches, present throughout, but most strikingly so in the bark, are of an inspissated resinoid juice, and constitute the feature of special interest in the specimen.

PLATE VI.

Fig. 1.—Flower of *Deutzia gracilis*, natural size, to show the position whence the figures have been taken.

,, 2.—Portion of the ovary, with stellate hairs, × 50.

,, 3.—Portion of the petal on which these hairs are also sparingly present, × 50.

,, 4, 5.—Pollen of *Oxalis acetosella*, end and side views.

,, 6.—Empty egg-shell of Bot-fly, seen in profile.

,, 7.—One of the lids.

,, 8.—Outline of another lid, curled during the process of preparation for mounting.

,, 9.—Part of one of the shells more enlarged, to show that the apparent hole is but a deep depression. The scale-like reticulation near the upper edge of a specimen is also shown, as well as the way in which this passes gradually into undulated transverse lines.

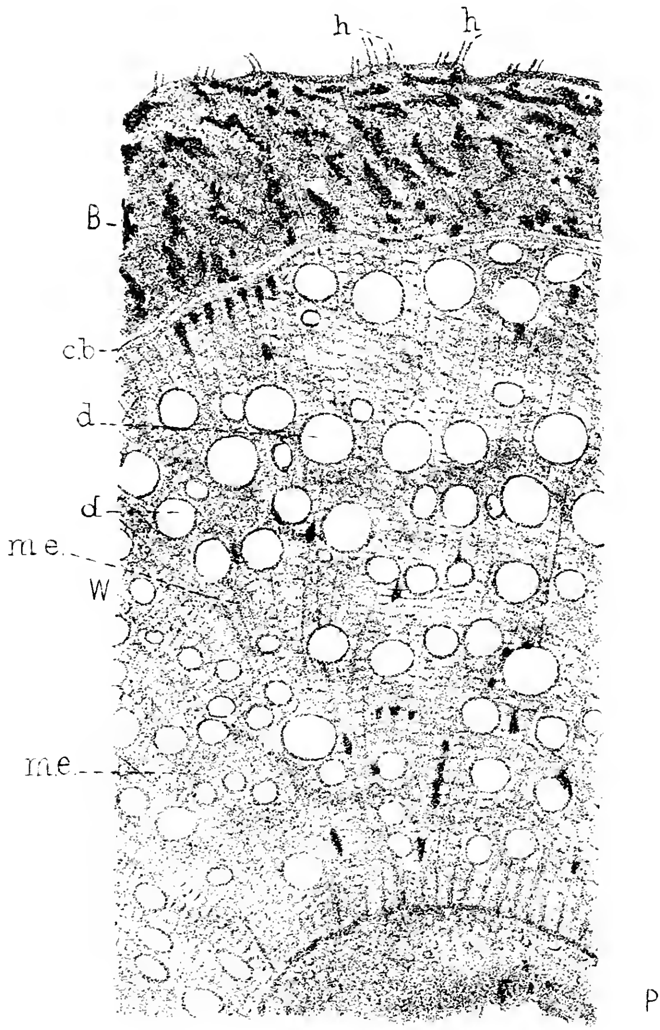
,, 10.—Front view of the upper part of the opening, to show the deep hollow, now looking much like a hole.

,, 11.—Edge of a part of a specimen, to show the wavy transverse lines to be really projecting ridges.

,, 12.—Transverse section of egg-shell of *Acrida viridissima*, drawn by A. Hammond.

,, 13.—Stomach of Bee, showing the beautifully arborescent character of tracheæ supplied to that part of this insect.

Plates IV., V., and VI. drawn by Tuffen West except Fig. 12, Plate VI.



x 50

Trans. Sec. Stem of Periploca græca

Stellate Hairs Deutzia
Stomach of Bee — — Egg of Bot Fly

Queries and Replies.

[As the *Scientific Enquirer* is now discontinued, we shall publish in each issue of the Journal such Questions as we may receive, together with Answers to the same contributed by some of our specialists.—Ed.]

1.—What is the best way to harden the Earth-worm, so that sections may be cut from it? R. S. P.

Alcohol, I think, is the best medium. I have never tried to cut sections of earth-worms, but a few days ago I put a large slug in alcohol, and it is now hard enough to allow transverse sections to be cut from it with a razor. If the querist finds any difficulty in cutting after the alcohol hardening, he can easily cut them with a freezing microtome or by embedding in paraffin wax.

B.Sc., Plymouth.

2.—What is the best way to prepare and mount specimens of Stigmas to show Pollen-tubes? S. G.

The Antirrhinum pistil is a good one to show the pollen-tubes, but it is not in the stigma where they are to be found, but in the style. The greatest difficulty is not in the mounting, but in getting the pistil at the exact time when the pollen is throwing out the tubes. It is best mounted dry on one of the slides where the cell is made on the glass, or make a cell with a turn-table and Bates' black varnish or brown cement. By dividing the pistil in two halves, it is generally transparent enough to see through; if not, it can only be teazed out with needles or cut with a freezing microtome.

B.Sc., Plymouth.

3.—How are the Concentric Circles in a transverse section of Beet-root (looking like annual markings in timber) to be accounted for? R. S. P.

The well-known concentric rings of wood, broken up by medullary rays, which alternate regularly with the zones of bast, and which number as many as six or more in a strong one-year-old beet-root, are due to an anomalous secondary thickening or growth of the root. This anomalous thickening, which is met with in other plants besides beet, and the process which produces the phenomena that so closely resembles the annual rings in timber, cannot be fully explained without the use of many botanical terms. In the root of the beet, as the growth proceeds, there are differentiated in it strands of wood and of bast corresponding

to them, and medullary rays, which are further developed after the manner of normal secondary thickening. Later on, the growth of this secondary thickening zone ceases, and it is replaced by a new one similar to it, which had already begun to appear at the outer limit of the second layer of bast, in the form of tangential divisions, which arise at scattered points, and extend thence laterally all round. And since the same process is repeated, there arise in the beet-root the annular markings. This short explanation is condensed from De Bary's work, to which reference should be made for fuller details. H. W. LETT, M.A.

The concentric circles in beet-root are to be accounted for by the fact that the root is actually the stem of the plant, and the circles are those common to stems of exogenous plants.

B.Sc., Plymouth.

Reviews.

FRESH-WATER ALGÆ OF THE UNITED STATES (exclusive of the Diatomaceæ), Complemental to Desmids of the United States; with 2,300 illustrations, covering 157 coloured plates, including 9 additional plates of Desmids. By the Rev. Francis Wolle, member of the American Society of Microscopists. Royal 8vo. Vol. I., text pp. 364; Vol. II., Plates Nos. LIV. to CCX. Price $10.00. (London: Dulau and Co., 37 Soho Square.)

We have before us two magnificent volumes, containing a vast amount of most valuable knowledge. In the introductory chapter the author discusses the polymorphism of the Algæ and its bearing upon the system of classification, and suggests that sooner or later the whole system of classification must be changed.

In these volumes the Algæ are arranged under three classes, viz.—Rhodophyceæ, Chlorophyceæ, and Cyanophyceæ, and are subdivided in the following manner:—

Class I.—RHODOPHYCEÆ.

Order I.—*Florideæ*. Families:—1, Lemaneaceæ; 2, Porphyraceæ; 3, Batrachospermaceæ; 4, Hildebrandtiaceæ.

Class II.—CHLOROPHYCEÆ.

Order II.—*Confervoideæ*. Families:—5, Coleochætaceæ; 6, Œdogoniaceæ; 7, Sphæropleaceæ; 8, Confervaceæ; 9, Pithopehraceæ.

Order III.—*Siphoneæ*. Families:—10, Vaucheriaceæ; 11, Botrydiaceæ.

Order IV.—*Protococcoideæ*. Families:—12, Volvocaceæ; 13, Protococcaceæ; 14, Palmellaceæ; 15, Chytridieæ.

Order V.—*Zygosporeæ*. Families:—16, Conjugatæ; 17, Desmidieæ.

Class III.—CYANOPHYCEÆ.

Order VI.—*Schizosporeæ*. Families:—18, Nostocaceæ; 19, Chroococcaceæ.

The descriptions, both of genera and species, are full and good; the measurements of the cells, spores, and filaments are given in micromillimetres. The labour of producing these volumes must have been immense, and we are

told it was performed by the author himself; and as doubtless a great majority of the forms described may be found in England, students will do well to secure a copy. The price in the United States is $10.00, or perhaps a trifle over two guineas, including postage.

Die Naturlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten inshe sondere den Nutzhflanzen bearebetit unter Mitwirkung zahlreicher hervorragender Fachgelehrten, Von A. Engler und K. Pranth. Royal 8vo. (Leipzig: Wilhelm Engelmann; London: Williams and Norgate. 1887.)

We have received the first twelve parts of this very important work. Each part consists of 48 pages, and is sold to subscribers at M1.50 (about 1s. 6d.). It is admirably illustrated with a great number of very fine wood engravings, showing anatomy, structural detail, etc. The orders which already have been treated of, either wholly or in part, are:—Palmaceæ, by O. Drude; Juncaceæ, F. Buchenan; Stemynaceæ and Liliaceæ, A. Engler; Cicadaceæ and Coniferæ, A. W. Eichler, A. Englar, and K. Pranth; Cyclanthaceæ, O. Drude; Hæmodoraceæ, F. Pax; Graminæ, E. Hackel: Gnetaceæ, A. W. Eichler; Araceæ, A. Engler; Amaryllidaceæ, Volloziaceæ, Taccaceæ, Droscoraceæ, and Iridacæ, F. Pax; Flagellariaceæ, A. Engler; Restionaceæ and Centralepidaceæ, G. Hieronymus; Mayacaceæ and Xyridaceæ, A. Engler; Eriocaulaceæ, G. Hieronymus; Rapateaceæ, A. Engler; Bromeliaceæ, L. Wittmack. It will be seen from the above that the list of collaborators is very large, and embraces the most eminent German botanists. Each order is treated in a thoroughly comprehensive manner under the following subjects:—Literature, Botanical Characteristics, Organs of Vegetation, Anatomy, Arrangement of Flowers and their Growth, Pollination, Fruit and Seeds, Geographical Distribution, Affinities, and Classification. In the 12 parts before us, no fewer than 1,950 illustrations have been given and described under 421 figures. We notice that the price to non-subscribers is M.3 for each part and to subscribers M.1.50 (1s. 6d).

The Flora of Howth. By H. C. Hart, F.L.S. Post 8vo, pp. 137. (Dublin: Hodges, Figgis, and Co. 1887.)

This book will prove interesting to the naturalist generally and to the botanist in particular. The introduction, which occupies 10 pages, gives an account of the geological and other features of the promontory. The village of Howth is situated about nine miles from Dublin. The author enumerates 545 species of plants found in the parish. A map of Howth (scale, 6 inches to the mile) will be found at the end of the book.

Journal of Morphology. Edited by C. O. Whitman, with the co-operation of Edward Phelps Allis, Junior. Vol. I., No. 1, Sept., 1887. Crown 4to. (London: W. P. Collins, 157 Great Portland St.; Boston, U.S.A.: Ginn and Co.)

The first part of this new and important work has come to hand and contains several valuable papers:—1.—*Sphyranura osleri*, a contribution to American Helminthology, by Profs. R. Ramsay Wright and A. B. Macullum; 2.—Development of the Compound Eyes of Crangon, by Dr. J. S. Kingsley; 3.—Eyes of Molluscs and Arthropods, by William Patten; 4.—On the Phylogenetic Arrangement of the Sauropsidæ, by Dr. G. Baur; 5.—A contribution to the History of the Germ-Layers in Clepsine, by C. O. Whitman; 6.—The Germ-Bands in Lumbricus, by Prof. E. B. Wilson; 7.—Studies on the Eyes of Arthropods and Development of the Eyes of Vespa, with Observations on the ocelli of some insects, by Dr. Wm. Patten. There are seven folding and one single plate. The whole work is handsomely got up on stout paper.

THE NATURALIST'S DIARY: A Day-Book of Meteorology, Phenology, and Rural Biology. Arranged and edited by Charles Roberts, F.R.C.S., L.R.C.S. 8vo, pp. xlvi.—368. (London: Swan Sonnenschein and Co.) Price 2s. 6d.

This book, which contains a coloured chart showing the blossoming of spring flowers in Europe, and a lengthy introduction on natural periodic phenomena, etc., should be the daily companion of every naturalist. It consists of a page for every day in the year, with blank spaces for memoranda on the following subjects:—Temperature, Barometer, Rainfall, Plants and Trees Blooming, Trees and Shrubs Leafing, Insects, Larvæ, etc., appearing, Fish, Reptiles, Birds' migration, song, nesting, etc., Animals seen breeding, etc., Shooting, Fishing, Sports, etc. This book is suitable for any year, and should be filled by daily entries during the year.

A MANUAL OF ELEMENTARY MICROSCOPICAL MANIPULATION, for the use of Amateurs. By T. Charters White, M.R.C.S., L.D.S., F.R.M.S., etc. 12mo, pp. 104. (London: Roper and Drowley. 1887.) Price 2s. 6d.

This little work is designed with the aid of affording the youngest beginner such directions for preparing objects of interest and instruction in an elementary but at the same time such a complete manner that he may grasp their details and work out his studies with the most satisfactory results. The author is so well known as a microscopist, that it appears quite superfluous for us to say anything further.

UNFINISHED WORLDS: A Study in Astronomy. By S. H. Parkes, F.R.A.S., F.L.S., etc. 8vo, pp. xii.—230. (London: Hodder and Stoughton. 1887.) Price 5s.

In the work before us, we have a brief summary of the results of recent scientific discovery regarding the present physical condition of those far-off worlds which the telescope and the spectroscope have revealed to us. It treats of Nebulæ, Coloured Stars, the Sun, the Earth, Jupiter, Mars, Comets, etc. The book is intended for general readers, and is well illustrated with lithographic plates.

SHORT STUDIES FROM NATURE. By various Authors. Cr. 8vo, pp. 386. (London: Cassell and Co.)

This interesting book has some very instructive and popularly-written chapters on Bats, Flame, Birds of Passage, Snow, Dragon Flies, Oak Apples, Comets, Caves, the Glow-Worm, and Minute Organisms, written by W. S. Dallas, F.L.S., Prof. F. R. Eaton-Lowe, Dr. Robt. Brown, F.L.S., and others. The chapters are well illustrated, a pretty plate showing various coloured flames forming the frontispiece. We notice that the wood engraving on page 146, which represents the dragon-fly emerging from the pupa, is reversed. We have read the book with much pleasure.

LIVING LIGHTS: A Popular Account of Phosphorescent Animals and Vegetables. By Charles Frederick Holder. Foolscap 4to, pp. xvi.-187. (London: Sampson, Low, and Co. 1887.) Price 8s. 6d.

The object of this splendid volume is "to interest young people in natural history by the presentation of an attractive—indeed, marvellous—phase of nature, and to encourage healthful outdoor observation, as well as habits of investigation." The descriptions of these wonderful animals and plants are so charmingly written, that, with respect to a great majority of his readers, the author cannot fail to attain his object. The illustrations are numerous and well-executed.

ANTS, BEES, DRAGON FLIES, EARWIGS, CRICKETS, AND FLIES. By W. Harcourt Bath. Cr. 8vo, pp. 108. (London: S. Sonnenschein and Co. 1888.) Price 1s.

We are pleased to welcome another of the Young Collector's valuable little handbooks. The one now before us treats of the orders—Hymenoptera, Neuroptera, Orthoptera, Hemiptera, and Diptera, and we are glad to find Mr. Bath endeavouring to encourage the study of these most interesting, though much neglected, order of the class INSECTA. The space at his disposal in so small a book is of course very limited. He has, however, done much by way of illustrations, of which we find no fewer than 156, to show the extent of the field open to the young collector.

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BIRD STORIES, Old and New, told in Pictures and Prose. By Harrison Weir. Sm. 4to, pp. 63. (London: Society for Promoting Christian Knowledge.)

Mr. Harrison Weir tells many interesting stories of birds in his own peculiarly pleasant manner; every page of the book is beautifully illustrated with a number of etchings. It is printed throughout in sepia-toned ink, on stout antique paper, which has altogether a pleasing, though somewhat unusual effect.

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GREAT WATERFALLS, CATARACTS, AND GEYSERS, described and illustrated. By John Gibson. Cr. 8vo, pp. 288. (London: T. Nelson and Sons. 1887.)

Describing the Falls of Niagara; of the Yosemite Valley; of the Yellowstone Region; Kaieteur Falls; Falls of Tequendama; Falls of Montmorency, Chaudiere, and Lorette; Cataracts of Orinoco and Parana: Falls of the Zambesi; Falls and Cataracts of the Nile; Falls of the Senegal; Cataracts and Rapids of the Congo; some Swiss Falls; Falls of the Clyde and Foyers; Cascade of Gavarnie; Geysers of the Yellowstone Region; Geysers of Iceland; and the Geysers of New Zealand. It is nicely illustrated with 32 plates.

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THE CONSTELLATIONS AND HOW TO FIND THEM. Thirteen Maps showing the position of the Constellations in the Sky during each month of any year. A popular and simple guide to a knowledge of the Starry Heavens. With introduction, general explanations, and a separate description of each map. By William Peek, F.R.A.S. Third edition, 4to. Price, 2s. 6d. (Edinburgh and London: Gall and Inglis.)

AN EASY GUIDE TO THE CONSTELLATIONS, with a Miniature Atlas of the Stars. By the Rev. James Gall. 16mo. (Edinburgh and London: Gall and Inglis.)

Two most useful books, by studying which a very fair knowledge of the constellations may be readily acquired. The star-maps in both books are printed in white on a very deep blue ground. The constellations are very distinctly shown.

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HISTORY OF THE PACIFIC STATES OF NORTH AMERICA. By Hubert Howe Bancroft. Central America. Vol. II., from 1530—1800. (San Francisco: The History Pub. Co.)

We have here an account of the Conquest of Peru; the Government of Castilla del Oro; the Colonisation of Veragua; the Occupation of Guatemala, Honduras, Nicaragua, and Costa Rica; Affairs in Chiapas, Belize, and Panama; and the deeds of the Buccaneers—the adventures of Morgan and other piratical raids—among other matters of interest are here given. The Revolt of the Natives, the Quarrels of the Spaniards among themselves, and the position of the Clergy in the affairs of conquest and occupation, are likewise clearly set forth. The volume is one of absorbing interest throughout.

PICTORIAL GEOGRAPHY OF THE BRITISH ISLES. By Mary E. Palgrave. Oblong 4to, pp. 102. (London : Society for Promoting Christian Knowledge. 1887. Price 5s.

This beautifully illustrated book teaches the elements of Physical and Political Geography by pictures as well as letterpress. Its various chapters describe how our Scenery was made ; a Summary of the British Scenery ; the Coasts, Mountains, and Hills ; Plains and Rivers ; Lakes and Islands ; Historical Scenery ; and the Industrial Geography of the British Isles. The pictures are numerous and effective.

PHYSICAL GEOGRAPHY prepared on a new and original plan. By John D. Quackenbos, A.M., M.D., John S. Newberry, M.D., LL.D., Charles H. Hitchcock, Ph.D., W. Le Conte Stevens, Ph.D., Henry Gannett, William H. Dall, C. Hart Merriam, M.D., Nathiel L. Britton, E.M., Ph.D., Geo. F. Kemtz, Lieut. George M. Stoney. Sq. 4to. (New York : D. Appleton and Co.)

With such an array of names we are naturally led to look for something unusually good, and we unhesitatingly say we are by no means disappointed. The work is illustrated with a great number of well executed engravings, diagrams, and maps in colours. Each author takes up the special subject for which he was most fitted, and, as a result, we have a work of uncommon excellence. Several schoolmasters, to whom we have submitted the book, speak of it in the highest terms. A chapter at the end of the book is devoted to the Geological History of the Physical features of the United States.

A DICTIONARY OF PLACE NAMES, giving the Derivations. By C. Blackie, with an Introduction by John Stuart Blackie. Third edition, revised. Cr. 8vo, pp. xl.—243. (London : John Murray. 1887.)

Geographical Etymology is a subject which is not so often studied as perhaps it might be. In this work the root words are arranged alphabetically, and as the names of Foreign as well as of English places are explained, the book will doubtless prove of special and peculiar interest to the tourist. It is undoubtedly the result of much patient research and study.

IMPERIAL GLOBE ATLAS of Modern and Ancient Geography, with Index of 20,000 Names. (London and Edinburgh : Gall and Inglis.) Price 3s. 6d.

This capital atlas consists of 33 imperial 4to maps (size, $14\frac{1}{2}$ by $11\frac{1}{2}$), nicely coloured and well engraved, and not so overcrowded with names as to be indistinct. The index to the 20,000 names occupy 32 very closely printed pages. This atlas is certainly a marvel of cheapness.

THE CREATOR, and what we may know of the Method of Creation. By W. H. Dallinger, LL.D., F.R.S., etc. 8vo, pp. 83. (London : T. Woolmer. 1887.) Price 2s. 6d.

This is the Fernley Lecture for 1887, and is, with the exception of some additional passages, printed as it was delivered. It addresses "thoughtful and earnest minds, not concerned specially with questions of philosophy, metaphysics, and science, but alive to the advanced knowledge and thought of our times, and anxious to know, so far as in such a form it could be expressed, how the great foundation of religious belief, the existence of Deity, is affected by the splendid advance of our knowledge of nature." It is a most carefully written discourse, and will unquestionably be read with profit by the thoughtful student.

Oxford, Cambridge, and College of Preceptors' Examination Papers. By Rev. George Litting, M.A., LL.B., and George Home. Cr. 8vo, pp. 180. (London Educational Supply Association.)

These questions embrace the following subjects :—Old and New Testament, English, Latin, and French Grammar, English History, Geography, Arithmetic, Algebra, Euclid, Mechanics and Hydrostatics, Botany, and Zoology. It is not pretended that they are the exact questions which will be set in any given subject in any of these exams, but are fairly representative, and the student will do well to master them.

The Examination Papers issued at the Ninth Examination held by the Intermediate Education Board, in June, 1887. 8vo, pp. 93. (Dublin : Browne and Nolan.) Price 1s.

These papers are prepared for Junior, Middle, and Senior grades of students, and embrace Greek, Latin, English, French, German, Italian, and Celtic ; Arithmetic, Book-keeping, Euclid, and Algebra ; Natural Philosophy, Chemistry, Botany, Drawing (Geometrical and Perspective), Music, and Domestic Economy. We feel that we cannot too strongly impress on intending candidates the necessity of studying the last year's examination papers.

Stirring Adventures in African Travel. By Charles Bruce. Cr. 8vo., pp. 256. (Edinburgh : W. P. Nimmo. 1888.)

An interesting account of some of our great explorers—Mongo Park, Livingstone, Captain Speke, Sir Samuel Baker, Henry M. Stanley, and others. Lion Adventures, Elephant, Buffalo, and Rhinoceros Hunting ; Shipwreck, Captivity, and Bombardment. The book abounds in Natural History incidents, and will be found both interesting and instructive. It is well illustrated.

Facts and Fictions of Mental Healing. By Chas. M. Barrows. Cr. 8vo, pp. 248. (Boston, U.S.A. : H. H. Carter and Karrich. 1887.)

The author tells us "he has not sought to compel the reader's assent, but that it has been his aim to awaken thought, and deepen the reader's interest, by fairly stating the evidence both for and against mental healing, and leave him to decide for himself." He further says, "There are facts that prove the possibility of such cures without a peradventure ; there are fictions, also, which must be abandoned, if mental healing is to get and retain a hold upon the popular attention."

Ten Great Events of History. Compiled and arranged by James Johonnot. Cr. 8vo, pp. 264. (New York : D. Appleton and Co. 1887.)

The ten epochs here described are those that have been potential in shaping subsequent events, and in which men have struck blows for human liberty, against odds, and regardless of personal consequences. They are—The Defence of Freedom by Greek Valour ; Crusades and the Crusaders ; Defence of Freedom in Alpine Passes ; Bruce and Bannockburn : Columbus and the New World ; Defence of Freedom in Dutch Dikes : The Invincible Armada ; Freedom's Voyage to America ; Plassey, and how an Empire was Won ; Lexington and Bunker's Hill. The book is nicely printed and illustrated, and the events are well described.

FACTORS OF LIFE. Three Lectures on Health, Food, and Education. By H. G. Seeley, F.R.S. Post 8vo, pp. 191. (London: Society for Promoting Christian Knowledge.)

This is a volume of the well-known "People's Library," and treats of the three subjects in a plain and forcible manner, and will well repay thoughtful reading.

QUEER CHUMS: Being a narrative of a Midshipman's Adventures and Escapes in Eighteen Hundred and —— War-time. By Charles H. Eden. Illustrated by W. H. Overend. Cr. 8vo, pp. xii.—312. (London: Society for Promoting Christian Knowledge.) Price 3s.

This exceedingly interesting story is founded chiefly on facts that came under the author's notice, and will be read with delight by many of our young friends. It has several illustrations.

PRACTICAL CHEMISTRY: a Course of Laboratory Work. By M. M. Pattison Muir, M.A., and Douglass Carnegie, B.A. Cr. 8vo, pp. viii.—224. Price 3s.

ELEMENTARY CHEMISTRY. By M. M. Pattison Muir, M.A., and Charles Slater, M.A., M.B. Pp. viii,—368. Price 4s. 6d. (Cambridge University Press; London: J. C. Clay and Sons. 1887.)

These two books are intended to be used together, the one being complementary to the other, their object being to teach the elements of Chemical Science. The author's aim has been to arrange a progressive course of practical chemistry, in which as the experiments become more difficult, the reasoning becomes more close and accurate. Appendices are added, giving outlines of experiments on parts 1 and 2. Tables for easy qualitative analysis and numerical data, including logarithms and antilogs. The authors tell us they entertain views rather different from those which generally prevail regarding the relative importance of the various parts of chemistry. They have endeavoured to make the teaching given in this book sound, so far as it goes; and have endeavoured to blend together the facts and principles of the science, and at the same time to avoid speculation.

THE CREMATION OF THE DEAD considered from an Æsthetic, Sanitary, Religious, Historical, Medico-Legal, and Economical Standpoint. By Hugo Erichsen, M.D., with an Introductory Note by Sir T. Spencer Wells, Bart., F.R.S., late President of the Royal College of Surgeons of England, Surgeon to the Queen's Household. Cr. 8vo, pp. xiv.—264. (Detroit, U.S.A.: D. A. Haynes and Co. 1887.)

It is unnecessary to state that the writer of this book most unquestionably believes in Cremation as the best mode of disposing of the dead; he tells us in his preface that "for all who like cleanliness, for all who love true sentiment, for all friends of economy, for all who venerate their dead, and for all who are not afraid of reform, the book was written." We have read the book with much interest, and can cordially recommend it to the notice of our many readers. It is well illustrated.

DAINTY DITTIES; or, Old Nursery Rhymes with New Tunes. By Frank J. Allen. (London: Novello, Ewer, and Co.) Price 1s. 6d., or bound in cloth, 2s. 6d.

The author of this charming little collection of melodies will be remembered by many "Postal Microscopists" as a former member of the Society. Many of the settings are very quaint and original.

A MANUAL OF BUHL-WORK AND MARQUETRY, with Practical Instructions for Learners, and 90 coloured designs. By William Bemrose. Third edition, 4to, pp. 32. (London : Bemrose and Sons.) Price 6s.

This is published as a sequel to two other works—"Manual of Wood-Carving" and "Fret-Cutting," and is written for the instruction of amateurs; the instructions being given in clear and simple language, free from all trade technicalities, and accompanied by a series of progressive designs, which are calculated to aid the student in the attainment of considerable excellence in the art. In our estimation the professional wood-carver may study this book to advantage. The coloured plates of designs are well executed.

ROUND NATURE'S DIAL. By Helen Marion Burnside. Cr. 4to, pp. 180. (London : George Routledge and Sons.) Price 6s.

This splendid book for young people is divided into four sections—Spring, Summer, Autumn, and Winter, and is beautifully illustrated by A. W. Cooper, engraved and printed in colours by Edmund Evans.

PRACTICAL GUIDE TO PHOTOGRAPHY. By Marion and Co. New edition, revised and enlarged. Cr. 8vo, pp. viii.—229. (London : Marion and Co., Soho Square. 1887.) Price 2s. 6d.

This very useful book, after commencing with a historical sketch of Photography, gives thoroughly practical details of the process, and a chapter on the Ferro-Prussiate process, enlarging, and lantern slides. There are a number of illustrations.

A HISTORY OF PHOTOGRAPHY, written as a Practical Guide and an Introduction to its Latest Developments. By W. Jerome Harrison, F.G.S. 8vo, pp. 136. (New York : Scoville Manufacturing Co. 1887.)

This nicely got up volume gives a History of Photography from its origin, and describes the various methods that have been employed from the time of Daguerre to the latest methods now in use. It contains also an Appendix by Dr. Maddox, on the discovery of the Gelatino-Bromide Process, a Biographic Sketch of the author, and a Portrait by the Moss-Type Engraving Co.

PRINCIPLES OF EDUCATION PRACTICALLY APPLIED. By J. M. Greenwood, A.M. Cr. 8vo, pp. 192. (New York : D. Appleton and Co. 1887.) Price, $1.

The author tells us that his object is to impress upon the minds of teachers the important question—"How shall I teach so as to have my pupils become self-reliant, independent, manly men, and womanly women?" And, in plain language, he tells the teachers what to do as well as what to avoid. His directions are simple, pointed, and emphatic.

SHORE AND SEA; or, Stories of Great Vikings and Sea-Captains. By W. Davenport Adams. Cr. 8vo, pp. vi.—348. (London : Hodder and Stoughton. 1887.) Price 5s.

The first portion of this book deals with the adventures of the old Norsemen, who made their way to Iceland, Greenland, and Labrador. Then we have the story of Sebastian Cabot, and of De Soto and his conquest of Florida; followed by an account of the early colonizers of Virginia; the Deeds and Sufferings of Henry Hudson, etc. The book is very interesting and nicely illustrated.

Our Home. Our Friends. Our Pets. (London: Routledge and Sons.)

Three books of Original Verses, written by Mrs. Sale Barker, editor of "Little Wide-Awake," very beautifully illustrated by F. A. Fraser, Paul Hardy, and A. W. Cooper. The verses are charming, and the illustrations are uncommonly nice. We notice that "Our Home" is printed by Ernst Haufmann, at Lahr, Baden, and "Our Friends," under the direction of Otto Mayer, by Judd and Co., London.

Sandy Ross: A Tale of the Sea. 12mo, pp. 96.

Arctic Stories. 12mo, pp. 96. (London and Edinburgh: Gall and Inglis.)

Two very interesting and nicely-illustrated tales for young people, suitable as presents for them.

Every Band of Hope Boy's Reciter. Vols. 1 and 2, containing Original Recitations and Dialogues. By S. Knowles. Royal 16mo, pp. xiv.—384. (Manchester: Brook and Chrystal; London: National Temperance Publication Depôt, 337 Strand.) Price 1s. each.

A lot of good temperance recitations and dialogues in prose and verse, suitable for young people's gatherings and Band of Hope meetings. Vol. I. is in its eighth and Vol. II. in its third edition.

The Silver Voice: A Fairy Tale. Post 8vo, pp. 57. Price 1s. 6d.

The Bairn's Annual. 8vo, pp. 192. (London: Field and Tuer, The Leadenhall Press.)—Two exceedingly amusing books for the young. The very comical illustrations in *The Silver Voice* are hand-coloured.

The Journal of the Royal Microscopical Society for October contains a Monograph of the Genus Lycoperdon, by G. Mason, with 2 plates.

Science Gossip for December has the continuation of an article on Slug Gossip, and the continuation also of Notes on the Common Frog in a state of Domestication; and many other papers of general interest.

The World's Inhabitants; or, Mankind, Animals, and Plants. By G. T. Bettany. (London: Ward and Lock.)—Parts 1 and 2 are occupied with the Inhabitants of Europe, commencing with the Early Inhabitants of the British Isles; has reached (chap. xi.) The Belgians. These numbers are well illustrated.

Amateur Work. (London: Ward and Lock.)—In the December number of this useful work are instructions for making a very cheap microscope, and a lot of other articles interesting to the amateur. The new volume commenced in November. Each number contains a large plate of full-sized working drawings for some useful articles of furniture.

Our Earth and its Story. Edited by Dr. Robert Brown. (London: Cassell and Co.)—Part XI. (December) contains a coloured chart, showing the Distribution of Saltness in the Ocean. The chapters in the present part describe Valleys and Fjords, their nature and origin; Marine Denudation; and the Formation of Coast Scenery. The illustrations are good.

Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part II.

Plates VII. and VII.

A SERIES of sections taken from a single egg on March 5th is shown on Plate II., as stated in our first article, p. 38. The form of this specimen had by this time become considerably modified from its original spherical shape, a portion represented by Figs. 6 to 13 having become flattened and elongated. The yelk mass also is penetrated by two distinct cavities formed by the invagination of the outer layers seen in Figs. 1, 2, 10, 11, and 12. These cavities form respectively the neural canal and the mesenteron, which are connected behind, and together form an external opening, termed the blastopore. This is the only opening into the egg, the whole of the exterior, besides this minute hole, being surrounded by the epiblast. This blastopore appears ultimately to produce the anus, which in its early stage is termed the proctodeum.

In the axial dorsal line, a portion of the mesoblast now separates into a gelatinous-looking rod forming the notochord. This notochord, though not permanent in the perfect animal, will be found to exist throughout the greater part of the embryonic life, and at once indicates a theoretical, developmental connection between the frog and the amphioxus, in which the notochord is permanent.

What the use of this notochord is would be very difficult to say, as it appears to have no permanent connection with any of the essential organs of animal life, and is not concerned in the direct development of the vertebral column as might at first sight be supposed. From this time the egg commences to flatten and elongate, the whole of the internal organs appearing with great rapidity. On March 7, the formation of a true skin or epidermis from the epiblast was distinctly seen to have commenced, and at

the same time the division of portions of the yelk mass into segments or somites, together with decided indications of the formation of the branchial arches, could be traced sections of the animal at this period, as given in Plate VII.

Fig. 1 shows the general external appearance of the embryo at this date, whilst Figs. 2 and 3 give vertical longitudinal sections, and Figs. 4 and 5 oblique ones, passing through the frontal nasal process from between the letters *g.—fn.*, Fig. 2, upwards through the neural and body cavities. We thus obtain sections of some of the more important organs which are now forming. Especially, we notice the brain, the notochord, and pro-renal ducts. These pro-renal ducts will be much better made out in the longitudinal sections taken on March 8th and following dates. The frontal nasal process is a ridge or protuberance extending the whole length of the body and terminating at the top of the head, not abruptly, but gradually merging into the rest of the epidermis. As the animal grows, it is gradually obliterated.

In Fig. 1 of this Plate attention should be drawn to the dark mass on the lower portion of the head, which will be found in future sections to consist of a muscular growth called the claspers, whereby the animal, during a certain portion of its existence, attaches itself to any neighbouring objects.

In Fig. 2, Plate VII., the dark portions marked *s.* indicate the position of the somites, segments which ultimately enclose the vertebral column, so that the indentation in this and the next figure really represents the back or dorsal region, whilst the opposite side, which has more the appearance of a back, is actually the ventral portion. It is thus seen that the greater number of organic changes occur in the head and dorsal regions, whilst the ventral side is still filled with undifferentiated yelk mass, merely surrounded by the three layers of epiblast, mesoblast, and hypoblast.

Sections taken on the succeeding day (March 9th) showed an immense advance in growth. All those organs which previously were only indicated in position by slight differentiation of the yelk mass had now become more distinct, whilst other parts were readily made out.

Fig. 1, Plate VIII., shows a vertical, longitudinal section of this

date, whilst Figs. 2 and 3 are vertical and horizontal longitudinal sections two days later (March 11th), and Fig. 4, a section of March 12th. Here it will be observed that brain, somites, notochord, and claspers have all undergone a continuous and marked increase in development, and in addition we have a mouth-cavity forming, together with the pericardium, and an immature heart within it. The notochord is well seen in Fig. 2 embraced by a number of the somites; whilst in Figs. 3 and 4 there are distinct indications of both cerebrum and cerebellum, together with some of the organs of special sense, as the auditory and optic sacs. The pro-renal ducts, commencing just under the gill-arches and running down the whole length of the body, merging at last into a thin line of mesoblast, are also well seen in Fig. 3.

Not less important than either are the distinct advances made in the growth of the gills. In Figs. 3 and 4 we see the gill-arches, with the gills within them, well protruding from the sides of the head. In the living animal it was not possible at this date to observe anything like a circulation or any special aeration of blood-corpuscles occurring in these immature gills. Indeed, from the extremely elementary condition of the heart, it is not probable that blood had yet commenced to form from any of the nucleated cells.

In order to see whether it were possible to throw any light on the physical changes occurring during development, it was attempted to take the specific gravity of the animals at various stages of their progress. Peculiar difficulties presented themselves during this part of the investigation owing to the enveloping batrachin attaching itself with the greatest pertinacity to the enclosed embryo. It has been previously mentioned that the specific gravity of the envelope itself was as nearly as possible that of water or very slightly less. Whilst this was the case, it was found that the embryo had a specific gravity decidedly greater than that of water, and varying also from day to day according to the progress of the development. The first attempts at obtaining the specific gravity were made by immersing the embryos, freed as far as possible from their envelope, in solutions of salt of various densities. This, of course, stopped all life; therefore, in the later stages, it was attempted to obtain correct results by

resting the animal for a short time on absorbent tissue, such as blotting-paper or linen, till the epidermis was nearly dry, and then quickly weighing first in air and then in water, the specific gravity being obtained in the usual way by dividing the loss of weight in water by the weight in air. As of course it was quite impossible to attach the embryo or animal to a hair or other non-absorbent material without injuring it, a specific-gravity bottle, with wide mouth and grooved stopper, was utilised for the purpose. The animal could be thus twice weighed with a minimum of discomsort, no permanent injury having apparently been inflicted on a single specimen during the process. A little difficulty, indeed, was at times experienced during the weighing in air from the lively nature of some of the specimens after their legs had appeared and before the tail was entirely absorbed. These lively individuals, by applying their moist though not wet bodies to the sides of the dish, would rapidly crawl, or rather glide, to its edge, and there remain perched generally a sufficiently long time for the weighing to be accurately performed.

Getting a little older, and perhaps bolder, some of them would with a bound spring from the bottom of the receptacle to the edge, and from thence take a long leap into the outer world. Not a very extensive world either, as far as they were concerned, for the majority of these tiny creatures failed to jump farther than the bounds of the balance case, whence they were soon restored to their own element. One huge fellow, however, who had grown and fattened on the best of the land, or rather water, after having experienced this kind of treatment two or three times on various days; in his attempts to baffle any further experiment on himself, took such a desperate leap just as the weighing was finished as to alight on the floor, having fallen through the enormous height of about four feet, or approximately from seventy to eighty times his own height. There he lay, poor wretch, apparently dead, but in reality only stunned, for on carefully picking him up in order not to lose the carcase altogether he showed such renewed signs of animation as to lead me at once to replace him in his tank, where he lived and grew many days after. But more of this individual at a later stage of our history. The results obtained by this process of taking specific gravities were most interesting.

The embryo in the stage represented by Plate II. had a specific gravity of 1·027, but owing to the absorption of the segmentation cavity, this had increased in five days to 1·068, which was the highest density observed, and from this time the density gradually diminished. Thus, on March 7th, the density being 1·068, it was 1·0612 on March 10th, and 1·062 on the 12th of the same month. These weighings were made on embryos developing from spawn laid on March 2nd, 1885, and were in about the same stage of development as those figured in Plate VIII., Vol. I., as they had just emerged from their encircling envelope, and were able to commence using their tails whilst holding on by means of the claspers, to the sides of the aquarium or to the envelope from which they had escaped. The remainder of the specific-gravity estimations were not undertaken till two years after—namely, in the spring of 1887.

From the 10th of March the specific gravity went on slowly decreasing, till on June 22, when the tadpole was at its highest stage of development as a tadpole, and before its legs had commenced to protrude, the specific gravity had sunk to ·774. The weight of the animal thus experimented on in air was 3·6 grains, and the weight of water equal in bulk to itself was 4·65 grains, thus giving its weight as ·774 as compared with the weight of an equal bulk of water.

We thus find that at this stage of its development the animal is decidedly lighter than water, and this is apparently due to the power of taking in considerable quantities of air, which may be expelled after having been used for respiration; and I believe, though I am not positive on the point, when the animal wishes to sink and remain at the bottom, a portion of this air is condensed and its place supplied by water.

Continuing our investigations on these specific-gravity experiments, we find that as the legs grow and the tadpole merges gradually into the state of the perfect animal, it becomes again comparatively heavier, its density becoming as nearly as possible that of water. Thus, the same animal, with its hind legs just appearing through the skin, weighed 4·1 grains, and had a density of ·752; with hind legs well developed, it weighed 5 grains; with a density of ·869; and when the forelegs had also protruded, the

gravity was ·900. The well-matured animal, with hind and fore-legs well developed and tail nearly or quite absorbed, had in every case in which an estimation was made, a density distinctly higher than that of water, and approximating to the density of the original embryo. In a series of determinations of the densities of animals in various stages of development, from the time their hind legs began to protrude to the time the tail had become completely absorbed, the following numbers were obtained:—Tail, half absorbed—Density, ·956; still further absorbed, ·962, 1·010, 1·011, 1·015, 1·020, 1·021, 1·028, 1·033, 1·034, 1·049, 1·066.

In taking these specific gravities, it is most important that the water remains at the same temperature throughout, and that its weight be accurately known, for as the weight of the animal generally varies from 1 to 5 grains, a very slight variation in the weight of the water in which the experiment is conducted may make a very serious error in the apparent density of the creature. When, however, all proper precautions are taken, it is evident, from the figures obtained, that the estimation of the specific gravity of animals in different stages of their development may prove of great assistance in physiological investigations.

As a special case, may be mentioned its use as an aid in another portion of the present investigation. Whilst the tadpoles were losing their tails, it was observed that they did not apparently eat, or at least they fed to a much less extent than previously. The balance was called in as an adjunct, with the following results:—The large specimen previously mentioned was weighed almost daily from the time that the tail commenced to be absorbed until the operation was complete, when it was turned out into a field to shift for itself. This process of tail-absorption was accomplished in five days, the weight on July 12, when the absorption commenced, being 10·6 grains, with a specific gravity of 1·029, and on July 17th, when the tail was entirely gone, the animal weighed only 9·5 grains, with a density exactly that of water. We thus see that in this case the animal, during the last stage of its metamorphosis from tadpole into frog, lost over 10 per cent. of its weight, and at the same time decreased in specific gravity. The reason of these changes in the specific gravity of these animals during different periods of their metamorphoses will

be seen more clearly as we proceed with their life-history.

Having seen it stated that tadpoles would not develop if kept in the dark, a few experiments were made on this point. Embryos of the age shown in Plate VII. were placed in a perfectly dark jar on March 7th, and kept side by side with those developing in the ordinary glass tanks, so as to be exposed to the same external conditions, with the exception of the exclusion of light.

At the same time, another batch from the same lot was placed in a dark cupboard at the top of the house, where the temperature was frequently below freezing and never above 40° F. These were in a glass jar, and were, of course, under very different conditions to those kept in a room where the maximum temperature might sometimes be 55° to 60° F., but whose minimum never went below 40°. On March 18th it was found that the development of the animals kept in the jar had proceeded equally with those kept in the glass tanks, the only appreciable difference being that those kept in the dark were on the whole a shade lighter in colour than those kept in the glass tanks. It was, however, very different with those in the cupboard, many of which were dead and all much arrested in development. All were dead by March 28th; several others being transferred from the dark jar to the cupboard, all died by April 5th. Suspicion was now cast on the glass vessel in which the animals were kept being the real cause of this wholesale destruction, so that another was substituted identical in every respect with that kept in the warmer room in the light.

A number was then transferred from the dark jar to the new glass vessel and removed to the cold dark cupboard. By April 11 five only remained, and by May 4th, barely a month after they were placed in the cupboard, all had died. As there were no apparent circumstances connected with the surroundings or atmosphere of this cupboard to account for the death of all these animals, the only conclusion to which I could arrive from this series of experiments was that whereas development proceeded as well in the dark as in the light, provided the temperature did not fall below 40° F., yet on the removal of animals which were previously developing under these conditions to a lower temperature in darkness, development was arrested, and death invariably ensued.

We must now retrace our steps somewhat, in order to study the progress of those animals which were kept under what may be termed normal conditions. On March 11th some of them commenced to fall out of their investing capsules, and formed small masses at the bottom of the jar; and next day these were able to move their tails slightly, so as to wriggle a little higher up the glass. From March 12th to the 21st the weather was very cold, and development was arrested to a very considerable extent; but by the latter date many had external gills well developed and could swim easily, but preferred to remain close to the glass. Whether attached or not by their claspers is very difficult to state, as they could be removed with the slightest touch of a small pencil-brush, so that the attachment, if existing, was of the very slightest character. This, to me, seemed the more surprising, as the microscopic preparations showed that the claspers at this period were apparently powerful muscular appliances, capable of producing a partial vacuum if applied to a smooth surface. I therefore anticipated much greater difficulty than was really experienced in their removal.

The more prominent organs which had developed by this time, although not yet arrived to perfection, were:—(1) Brain, with cerebral vesicles, medulla oblongata, and medulla spinalis; (2) Notochord, terminating a little behind the pituitary vesicle; (3) Branchial, hyoid, and mandibular arches; (4) Pericardium, with enclosed heart; (5) Claspers; (6) Mouth-cavity; (7) Pro-renal ducts; (8) Somites; (9) Special-sense Capsules, as the auditory and optic and olfactory capsules, from which we shall subsequently find the ear, eye, and nasal organs to proceed.

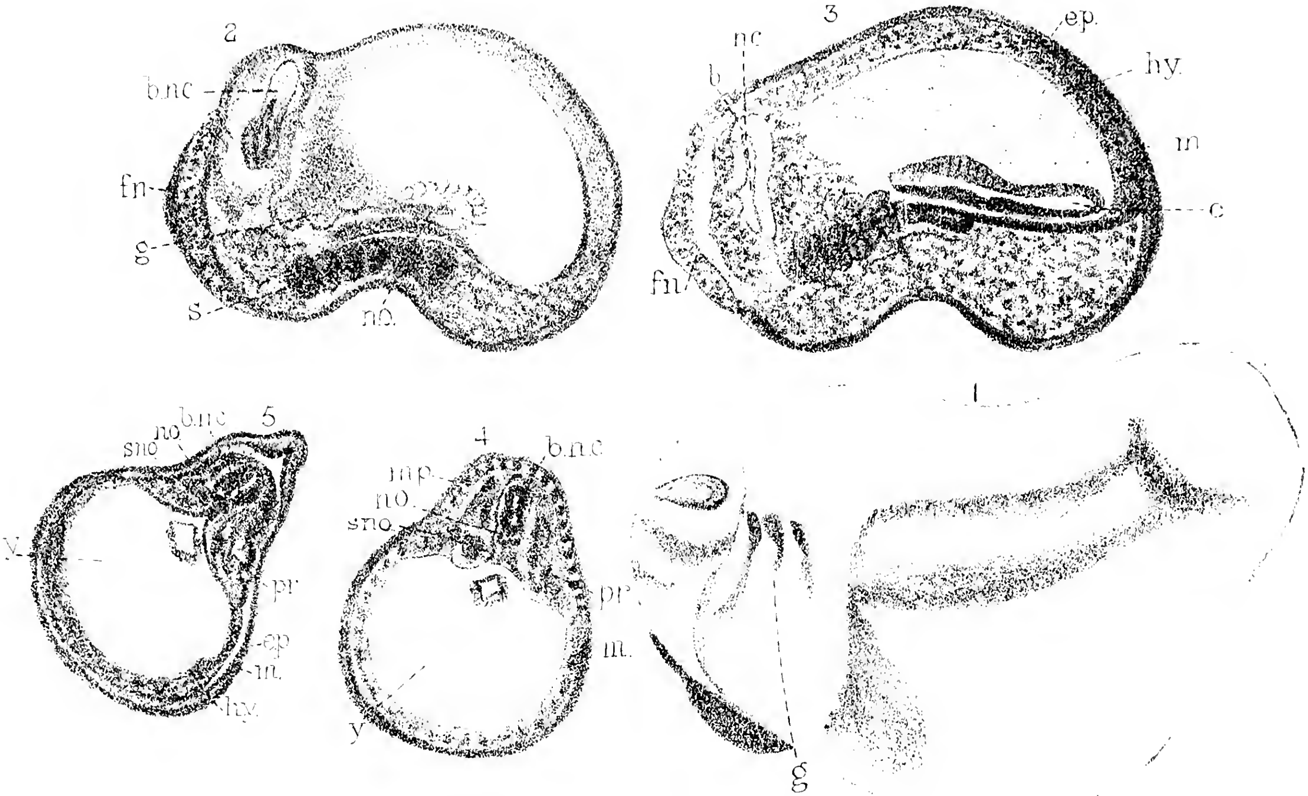
[TO BE CONTINUED.]

EXPLANATION OF PLATES VII. AND VIII.

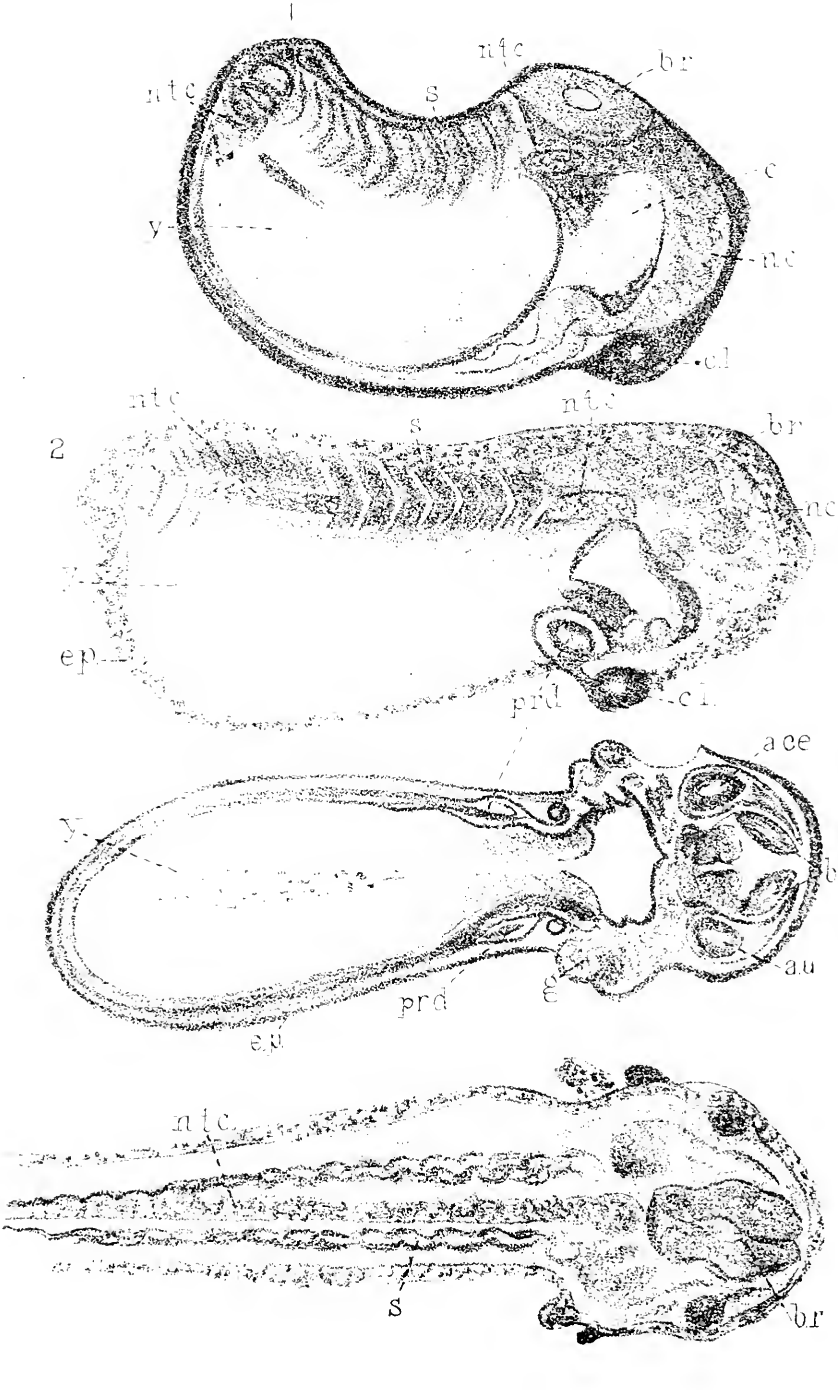
PLATE VII.

Fig. 1.—External appearance of the Tadpole, March 7, showing formation of *g.*, gill arches.

,, 2.—Vertical longitudinal section of same, showing *bnc.*, brain with neural cavity; *g.*, gill arches; *no.*, notochord; *fn.*, frontal nasal process; *s.*, somites; *y.*, yelk mass.



Development of the Tadpole



Development of the Tadpole.

Fig. 3.—Horizontal median section of same, same date: *ep.*, epiblast; *mf.*, mesoblast; *c.*, body cavity; *b.*, brain; *nc.*, neural cavity.

,, 4, 5.—Oblique sections of same through the head portion taking in part of the yelk mass; *mp*, muscle plate; *no.*, notochord; *sno.*, sub-notochordal rod; *pr.*, pro-renal duct, other letters as before.

PLATE VIII.

Fig. 1.—Vertical longitudinal section, March 9: *br.*, brain; *ntc.*, notochord; *cl.*, claspers; *s.*, somites; *c.*, body cavity; *y.*, yelk mass.

,, 2.—Vertical longitudinal section, March 11. *prd.*, pericardium, with immature heart.

,, 3.—Longitudinal horizontal section of same; *au.*, *au.* (marked *acc.* on plate), auditory capsule; *prd.*, pro-renal ducts; *g.*, gills; *br.*, brain.

,, 4.—Longitudinal horizontal section through, *ntc.*, notochord, March 12. Other letters the same.

THE PHOSPHORESCENT LIGHT OF GLOW-WORMS.—From the curious experiment mentioned in one of the late numbers of the *Moniteur de la Photographie*, in which a glow-worm acted, by the light emanating from its body, on a gelatine-bromide plate placed at the bottom of a darkened box, this light appears to be about of the same actinic intensity as the phosphorescent light of sulphuret of calcium. It appears that the light of glow-worms and of all phosphorescent animals is caused by a substance called *noctilucine*, which is secreted by the animal as it is used, and that the light is due to the slow oxidation of this substance. If some of these insects have been seen to retain their luminosity in a vacuum, or in hydrogen gas, it is because their tissue always contains enough oxygen to allow the slow oxidation of the noctilucine to continue under the circumstances for a certain length of time.

INSTINCT OF BIRDS.—It is reported in Peru and other parts of South America, last year's fruit has been avoided by birds, while it has caused the death of sheep and cattle when fed on them in large quantities. These observations have been cited as tending to show that the instinct of birds, with respect to the wholesomeness of fruits, is frequently a worthy guide for human beings to follow. The possibility is suggested that the variation in the fruit of different years may have something to do with the outbreak of cholera.

Equisetaceæ:

Life-History, Antiquity of Type, etc.

By W. G. Wheatcroft.

Plates IX., X., XI.

THIS is the name of a natural order of cryptogamic plants, which, whether regarded on account of their antiquity or wide distribution over the face of the earth, are worthy of careful consideration. This natural order contains only one genus, Equisetum, or Horsetails. The generic name is derived from *equus*, a horse, and *seta*, a hair or bristle, in allusion to the form of the stem. The Equisetum, Ephedron, and Anabasis of Pliny are supposed to refer to one or other of the plants of this genus. *Equiseta* are found in most parts of the world, but there are none in Australia or New Zealand. The tropics possess their species as well as the more temperate climes. A few of the species—as *E. variegatum*, *E. sylvaticum*, etc.—have a very wide distribution. *E. variegatum* occurs as far north as Iceland. It is also found in Quito, Bourbon, and Uitenhage; whilst *E. sylvaticum* is found from the Arctic regions of North America to Simla. *E. giganteum*, a Brazilian species, attains several feet in height, and possesses a stout stem, three-quarters of an inch in diameter. One species, on the contrary—*E. debile*—is so weak that it requires the support of low bushes, up which it may be said to climb, and Welwitsch describes *E. elongatum* as climbing up *Agave Americana* at Lisbon.

The properties and uses of Equiseta are few, whilst *E. arvense* is chiefly known as a troublesome weed to farmers, especially on ground which has been reclaimed from rivers, and in fields where water stagnates in winter. Almost the only useful purpose to which these plants have been put by man is that of polishing hard wood, iron, brass, etc. *E. hyemale*, commonly known as Dutch rushes, is chiefly employed for this purpose. Carpenter states that in some species silex constitutes not less than 13 per cent. of the whole solid matter and 50 per cent. of the inorganic ash. It abounds especially in the cuticle, hence its use for polishing.

Some of the siliceous particles are distributed in two lines parallel to the axis; others, however, are grouped into oval forms, connected with each other, like the jewels of a necklace, by a chain of particles forming a sort of curvilinear quadrangle; and these (which are, in fact, the particles occupying the cells of the stomata) are arranged in pairs. Their form and arrangement are peculiarly well seen under polarised light, for which the prepared cuticle is a beautiful object.

Horsetails have been supposed to possess medicinal properties. *E. arvense*, L., as an astringent, was formerly much used in dysentery, ulcers of the lungs, phthisis, malignant fevers, etc. Gerard thus describes its vulnerary properties:—"Dioscorides saith that Horsetail being stamped and laid-to doth perfectly cure wounds; yea, although the sinues be cut asunder, as Galen addeth. It is of so great and singular virtue in healing wounds, as that it is thought and reported for truth to cure wounds of the bladder and other bowels, and helpeth ruptures and burstings." * How far these ascribed virtues are apochryphal and how far real, I leave for those who are learned in medicine and skilful in surgery to decide. I do not presume even to hazard an opinion.

The British Flora, according to Sir Joseph Hooker, contains eight species, viz.—*E. arvense*, L., *E. pratense*, Ehrh., *E. maximum*, Lam. (*E. fluviatile*, Sm., not L.), *E. sylvaticum*, L., *E. palustre*, L., *b. polystachya*, *E. limosum*, L., *b. fluviatile*, L., *E. hyemale*, *b. E. Moorei*, Newm., *E. variegatum*, Schleich, *b. E. arenarium*, Newm., *c. E. Wilsoni*, Newm., *d. E. trachyodon*, Braun. That eminent botanist, the late H. C. Watson, substantially agreed with this arrangement, and it is given in the 7th edition of the London Catalogue. The editor of the 8th edition of this very useful catalogue has, amongst many other changes which he has effected, given specific rank to *E. Moorei* and *E. trachyodon*. He agrees with Sir J. Hooker in giving three varieties to *E. variegatum*. Two of these he calls by the same names as Sir Joseph and Mr. Watson, whilst to the third he gives the name *majus*, after Syme. I call attention to these changes, as well for the purpose of identification as for showing how eminent botanists

* "Herbal," p. 1,116.

differ as to what entitles a plant to specific rank, and how unsatisfactory a condition classification is in this country at the present time. I must likewise call attention to a discovery recently made by a gentleman well known in the botanical world for his work amongst *Chara*. I refer to Mr. W. H. Beeby. Mr. Beeby seems to have found *E. litorale* in Surrey. He has published a full account of the plant in the March, 1887, number of the *Journal of Botany*. This plant is figured on the first page. Mr. Beeby observes that "the most noteworthy features about this plant are the abortive spores and the absence of elators." Hence Dr. Milde calls it "one of the most remarkable of Cryptogams." By several authors it has been considered a hybrid between *E. arvense* and *E. limosum*, but Dr. Milde concludes by saying ("Die Höheren Sporenpflanzen," p. 114) "that, considering the wide range of the plant, this supposition seems doubtful. Hybrid cryptogams in other cases, always appear singly, and as extraordinary rarities. The spores and sporangia are aborted in all the stations. Nevertheless, solitary green normal spores may always be found. At all events, I think, the life-history of this plant is not yet complete. Duval-Jouve considers it a good species, not a hybrid."

The Bath Flora contains five species of Equisetum, viz.—*E. arvense*, L., *E. maximum*, Lam. (*E fluviatile*, Sm.), *E. palustre*, L., *E. limosum*, L., and *E. hyemale.*, L. "The largest Equisetum of the present day," writes Berkeley, "is not to be compared with the noble representatives, as Calamites, which occur in the Coal Measures and the New Red Sandstone. True Equiseta also occur in a fossil state." But more on this subject hereafter.

I will now attempt to describe the form, structure, and habit of a well-known representative of the genus, and then call your attention to the life-history of the plant. Horsetails are vascular cryptogams. They possess true vessels and are characterised by the development from the spore of a leafless prothallium. This prothallium is above ground and green. The aërial stem springs from a creeping rhizome, which produces at its nodes a number of adventitious roots. The stem is herbaceous, usually furrowed, simple or branched, jointed, and provided at the joints or nodes with toothed sheaths, formed by the coalescence of the leaves at

their base. The habit of the plant depends on this mode of formation of the leaves, and on the verticillate arrangement of the branches, which spring from buds in the cortex. The stem, rhizome, and root are all derived from a single apical cell, which divides into three series of segments. In the internal structure of the stem the air-cavities are of great importance. Its centre is occupied by a large central air-cavity (Pl. IX., Fig. 1, *l'*), and in the surrounding ring of tissue, which is often rather narrow, there is almost always a cortical air-cavity (Fig. 1, *l*) between each pair of vascular bundles. In addition, there often occur also the so-called essential air-cavities (Fig. 1, *l''*) in the vascular bundles. The stomata (Fig. 1, *st.*) are usually placed in a single or in several rows between the elevated ridges of the stem. The cortex consists of thin-walled or of only moderately thick-walled parenchyma. It is separated on the inside from the vascular bundles by a sheath, which sometimes encloses all the bundles together (Fig. 1, *s.*). The vascular bundles ascend in a vertical direction and parallel to one another through the internodes, and form annular coils in the nodes; they are always "closed" bundles, containing no cambium. Two other groups of vascular cells are found on the cortical side of the bundle. The bast-portion contains three elements:—parenchyma, bast-fibres, and sieve-tubes; it lies between the four groups of vascular cells and the vascular bundle-sheath.

In the root is an axial bundle of vascular cells surrounded by elongated parenchymatous cells, with which sieve-tubes and bast-fibres are intermixed. The sporangia are capsules placed on the under-side of scales belonging to the fructification (Fig. 2, *p*). The fructification or receptacle is often placed on special shoots, which are distinguished by their external form and by their brown colour from the sterile green stems. The spores (*S.S.*) are provided with two hygroscopic bands or *elators* (Fig. 2, *S.e.*), only loosely attached to them, formed by the splitting into narrow strips and the partial detaching of the exospore or outermost of the three coats of the spore, and serving, by their hygroscopic properties, to assist in their dissemination. On germination, the spore gives rise, first, to a flat prothallium, upon which are produced the antheridia and archegonia (Pl. X., Figs. 1, 2, 3). Most

species of Equiseta are diœcious, the female prothallium being larger than the male. In the antheridia are developed a very large number of motile antherozoids; in the archegonium is a single central cell, containing an oosphere, which after impregnation develops gradually into the young plant. The alternation of generations is therefore precisely similar to that of ferns. The Equisetaceæ are also propagated in a vegetative, non-sexual manner, by means of subterranean stôlons and tubers. "The affinities of these plants," as Berkeley observes, "are quite clear since the discovery of the extreme similarity of the mode of development with that of ferns. The archegonia and spermatogonia, with their spermatozoids, are, in fact, almost identical. The resemblance to *Marchantiaceæ* in the fruit is striking, but this is rather one of analogy than of affinity, as the results of impregnation are so different. In *Marchantiaceæ* the archegonia produce merely a sporangium; in *Equisetaceæ*, a new plant. The resemblance between these plants, again, and such Phænogams as *Ephedra* and *Casuarina* is very striking, but it is, after all, merely analogical. "The superior development of the cellular tissue indicates a higher type than that of ferns, and if the nobler forms of these are objected, we have but to point to extinct *Equisetaceæ*."

A very interesting plant, which has no affinity with Equiseta, although both its botanical and English name would seem to point to a relationship, is *Hippuris vulgaris*, L., the Mare's Tail. It grows frequently in close proximity to *E. maximum*. I have gathered specimens of both, growing within a foot or so of each other, in the neighbourhood of this city (Bath). This plant seems at one time to have been classed with Horsetails. This was before compound microscopes were regarded as essential to the study of botany. The application of the microscope to a transverse section of the stem makes it manifest that the Mare's tail is an exogenous plant. Further examination shows that it is not a cryptogamic, but a flowering plant, for the flowers arise from the axils of the leaves. I have made a sketch of a transverse section of the plant, to enable you to compare it (Pl. X., Fig. 4) with one of *E. arvense*, L. (Pl. X., Fig. 5). If I am open to the charge of wandering away from the subject of my paper, I must plead in extenuation that I have done so for the purpose of

showing how effectually microscopic examination corrects some botanical errors, and I trust that you, as microscopists, will pardon the digression.

Let me now direct your attention to the subject of antiquity of type as manifested in the EQUISETACEÆ. I will then conclude with a few parting words on permanency of type as shown in this and some other portions of the vegetable kingdom. Although one or two naturalists of some eminence have expressed a doubt as to whether the Calamites of the Carboniferous period are true Equiseta, there can, I think, be no doubt that representatives of the order not only existed but occupied a prominent place in the Flora of the Coal period.

Palæontologists of no mean reputation give the primary representatives of the Horsetail family a place amongst the earliest traces of land vegetation yet discovered, namely—in the flora of the Old Red Sandstone or Devonian period. Pl. XI., Figs. 1 and 2, represent stems of Calamites found in the coal-beds of Europe. A careful examination of two slides I have lately obtained from Mr. Spencer, of Halifax—one of which contains a transverse and the other a longitudinal section of a species of Calamite found in the Halifax coal strata, has enabled me to form an opinion as to the vascular structure of these giants of the forest and marsh of the Carboniferous era. Calamites had peculiar roots. Fig. 3 is a representation of the radical termination of a Calamite. I think it is not improbable that the transverse section under observation has been taken from some part of the root of a Calamite. The dimensions of the section and other indications seem to point to this conclusion. I once possessed a fossil of a Calamite found in the coal-fields of Derbyshire which measured more than five inches in diameter.

An eminent French botanist, Adolphe Brogniart, has called the Carboniferous period "the age of Acrogens," so great appears to have been the numerical proportion of flowerless plants of the families of ferns, club-mosses, and horsetails. Brogniart reckoned the known species in 1849 at 500, and the number has been largely increased by recent research, in spite of reductions owing to the discovery that different parts of even the same plants have been taken for distinct species. "Brogniart's generalisation con-

cerning this flora," writes Sir Charles Lyell, "still holds true, namely—that the state of the vegetable world was then extremely different from that now prevailing, not only because the cryptogamous plants constituted nearly the whole flora, but also because they were, on the whole, more highly developed than any belonging to the same class now existing, and united some forms now only found separately and in distinct orders. The only phænogamous plants which constitute any feature in the coal are the coniferæ; monocotyledonous angiosperms appear to have been very rare, and the dicotyledonous, with one or two exceptions, were wanting."

I will quote Sir Charles Lyell once more as to the Equisetaceæ of the Coal period. This eminent geologist, referring to the Horsetails, observes:—"To this family belong two fossil genera of the Coal, Equisetites, and Calamites. The Calamites were evidently closely related to the modern Horsetails (*Equiseta*), differing principally in their great size, the want of sheaths at the joints, and some details of fructification. They grew in dense brakes on sandy and muddy flats in the manner of modern Equisetaceæ, and their remains are frequent in the coal. Seven species of this plant occur in the great Nova Scotia section, where stems of some of them, five inches in diameter and sometimes eight feet high, may be seen terminating downwards in a tapering root." The Brora coal, one of the most considerable Oolitic seams in Europe, seems to have been formed almost exclusively of an Equisetum, *E. columnare.* The Keuper beds in Wurtemberg attain a thickness of about 1,000 feet. The plants of the Keuper are generally analogous to those of the oolite and lias, consisting of ferns, equisetaceous plants, cycads, and conifers, with a few doubtful monocotyledons. "A few species," observes Lyell, "such as *Equisetites columnaris* (Syn., *Equisetum columnare*, Pl. XI., Figs. 4, 5, and 6), are common to this group and the oolite."

In the State of Virginia, some thirteen miles from Richmond, there is a coal-field occurring in the depression of the granite rocks, and occupying a geological position analogous to that of the New Red Sandstone of the Connecticut valley. It extends twenty-six miles from north to south and four to twelve miles from east to west. The fossil plants found there consist chiefly of

zamites, calamites, equiseta, and ferns. The equiseta are very commonly met with in a vertical position. "It is clear," observes Lyell, "that they grew in the places where they are now buried in strata of hardened sand and mud. I found them maintaining their erect attitude, at points many miles apart, in beds both above and between the seams of coal." We have, I think, ample proof of the existence of Equisetaceæ in the Carboniferous measures, in the Upper Trias and the Oolite. I think, therefore, that I have said enough in support of my claim to antiquity of type on behalf of the Horsetails.

Observations on antiquity of type naturally lead to remarks on permanency of type, a subject which, it seems to me, must strike every observer of vegetable life more or less forcibly. Plants constitutionally strong, like Horsetails, with something like armour plating for their protection, and possessing more than one mode of increasing their numbers, were admirably adapted to struggle against the many vicissitudes of climate and other trying conditions to which the early flora must have been subjected during the countless ages which have elapsed since the coal-measures were formed. The Glacial period, which must have sorely tried some of the strong and destroyed many of the weakly-constituted plants, seems to have worked little, if any, destruction upon Equisetaceous plants. They seem to stand in the foreground of witnesses to the doctrine of permanency of type. But they are not the only witnesses.

I must crave your attention for a few minutes longer, whilst I refer to some remarkable observations which have been made by Dr. Schweinfurth in the valley of the Nile. They are none the less worthy of consideration because they refer to what, for want of a better name, I will venture to designate the historic period. The president of the Linnæan Society, Mr. W. Carruthers, F.R.S., in his address to the biological section of the British Association, at their meeting held at Birmingham in 1886, after referring to the result of an examination of certain gravel-beds in the north of London, which contained stems and leaves of *Clematis vitalba*, L., willow and birch, the foliage and fruit of *Corylus Avellana*, L., and *Alnus glutinosa*, L., and the rhizomes of *Osmunda regalis*, L.—"none of which," as he remarked, "could be distinguished from

the plants of our own day"—observed as follows:—"The most important materials, however, for the comparison of former vegetation of a known age with that of our own day, have been supplied by the specimens which have been obtained from the tombs of the ancient Egyptians. Until recently, these consisted mainly of fruits and seeds. These were all more or less carbonised because the former rifling of the tombs had exposed them to the air. . . . The recent exploration of unopened tombs belonging to an early period in the history of the Egyptian people has permitted the examination of the plants in a condition which could not have been anticipated. And happily the examination of these materials has been made by a botanist who is thoroughly acquainted with the existing flora of Egypt, for Dr. Schweinfurth has for a quarter of a century been exploring the plants of the Nile Valley. The plant-remains were included within the mummy-wrappings, and being thus hermetically sealed have been preserved with scarcely any change. By placing the plants in water, Dr. Schweinfurth has succeeded in preparing a series of specimens gathered four thousand years ago, which are as satisfactory for the purposes of science as any collected at the present day. These specimens consequently supply means for the closest examination and comparison with their living representatives."

Mr. Carruthers states that Dr. Schweinfurth has determined no less than fifty-nine species, some of which are represented by the fruits employed as offerings to the dead; others by the flowers and leaves made into garlands; and the remainder by branches on which the body was placed, and which were enclosed within the wrappings. Mr. Carruthers has enumerated the names of the plants, fruits, and weeds found. These include the linseed still grown in the Nile Valley (*Linum humile*, Mill) and the berries of *Juniperus phœnicia*, L. The pests of the Egyptian corn-fields are not unknown to us, for Dr. Schweinfurth discovered *Medicago denticulata*, Willd., and *Sinapis arvensis*, L., var. *Allioni*, a nearly-related and equally objectionable weed with the well-known Charlock of our corn-fields. The flax-crops in the days of the Pharoahs seem to have been infested, as they are at the present day, by this most troublesome weed. Mr. Carruthers, after giving a very interesting account of the various plants found

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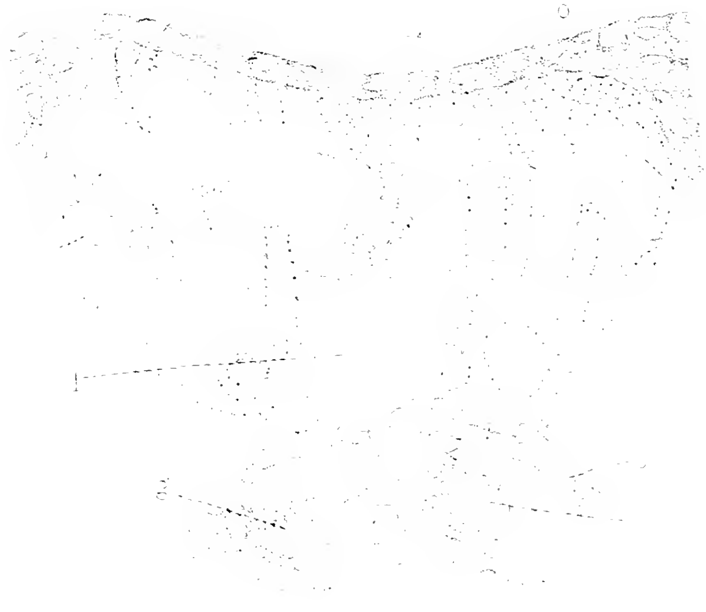

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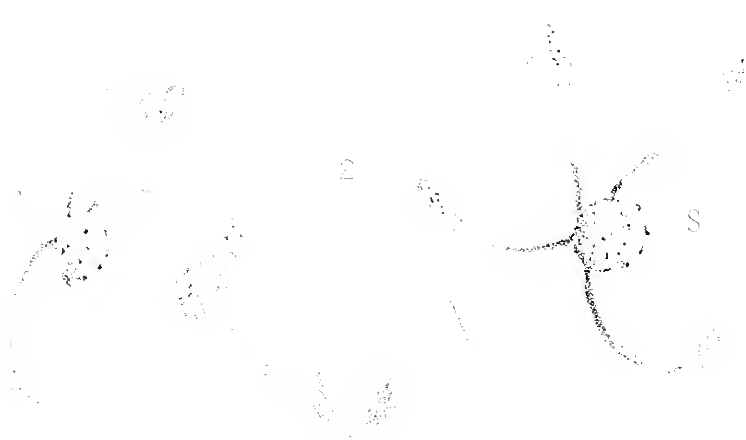
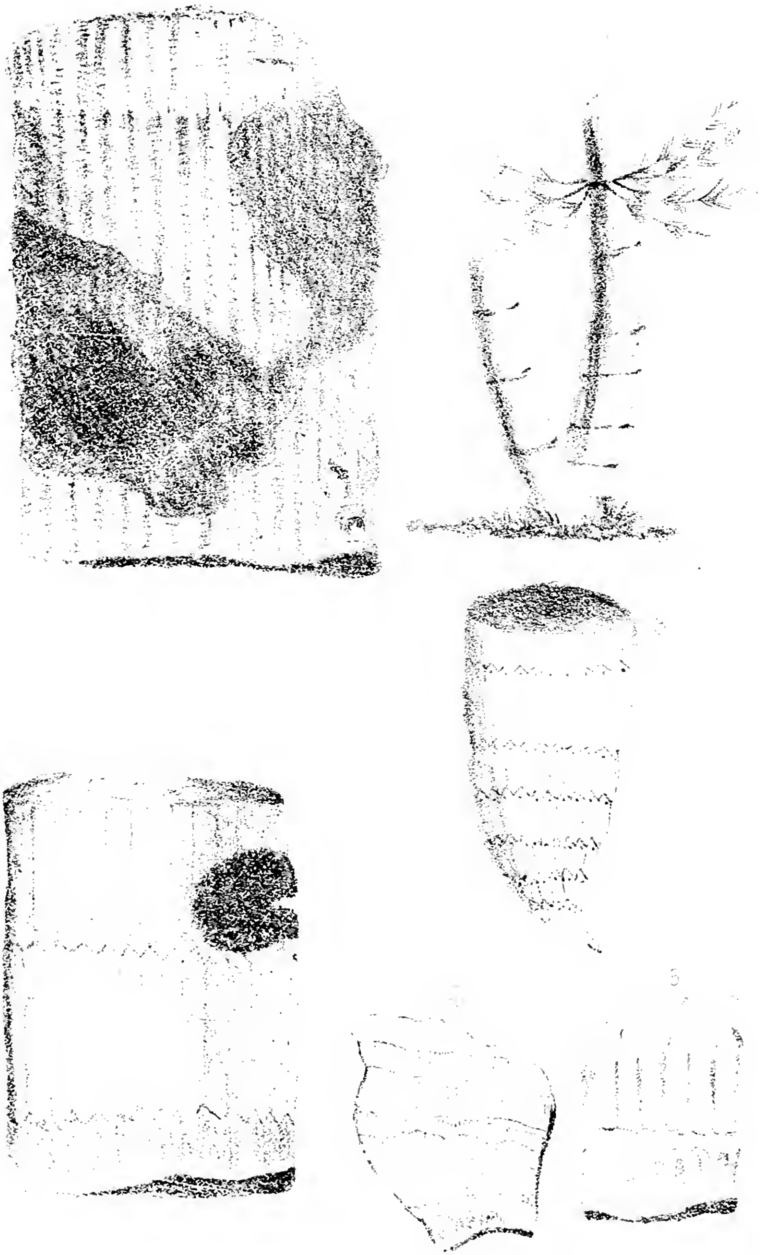




Equisetaceæ

in these mummy-wrappings, which time will not permit me to refer to more fully, observes:—"In none of these species, except the vine, to which I have referred, which Dr. Schweinfurth has discovered, and of which he has made a careful study, *has he been able to detect any peculiarities in the living plants which are absent in those obtained from the tombs.*" I venture to think that it would be difficult to produce better evidence of permanency of type. It is not my intention to base any theory on the facts I have called attention to. I leave that to those who possess a more extensive knowledge or a more lively imagination than I can lay claim to.

EXPLANATION OF PLATES IX., X., XI.

Plate IX.

Fig. 1.—Transverse section through young stem of *Equisetum sylvaticum*, showing:—*o.*, epidermis; *c.*, collenchyma, many of the cells containing chlorophyll; *s.*, vascular bundle sheath; *g*, vascular bundle; *l*, cortical air-cavity; *l'*, central air-cavity; *l''*, air-cavity of the vascular bundles; *st.*, stomata. After Thomé, × 150.

,, 2.—A peltate scale, bearing the sporangia on its inner side facing the stem, five being visible (highly magnified). *s.s.*, spores, with the elaters unrolled; *e.*, elaters. After Thomé.

Plate X.

Fig. 1.—Prothallium of *Equisetum maximum*, with eleven antheridia. *v*, prothallium; *a.*, antheridia.

,, 2.—Prothallium (*v*), with archegonia (*a.*), × 30.

,, 3.—An antherozoid, × 500. After Thomé.

,, 4.—Portion of transverse section of stem of *Hippuris vulgaris* (Mare's Tail); natural order, Halorageæ.

,, 5.—Portion of transverse section of stem of *Equisetum arvense*, showing:—*o*, central; *e*, cortical air-cavities; *p*, vascular bundles; *ep.*, epidermis; *s*, air-cavities of vascular bundles, × 50.

Plate XI.

Fig. 1.—Stem of Calamite, one-fifth natural size. After Figuier.

,, 2.—Stem of *Calamites sucowii*, Brong., as restored by Dr. Dawson. After Lyell.

,, 3.—Radical termination of a Calamite from Nova Scotia. After Lyell.

,, 4.—Fragment of a stem of *Equisetites columnaris*.

,, 5.—Portion of the same, magnified. After Lyell.

,, 6.—*Equisetum columnare*, natural size. After Hugh Miller.

All drawn by W. G. Wheatcroft.

Trap-door Spiders and their Nests.

By G. H. Bryan, B.A.

Plate XII., Fig. 1.

IN the hotter parts of the earth, the threads spun by spiders are often of considerable strength and toughness, and in some cases are sufficiently strong to strike off the hats of passing travellers or to be woven in looms like the fibres of the silkworm.

All the trap-door spiders are remarkable for the great strength of their webs, which are used, not for the capture of prey, but for the strengthening of their earthen homes. The silk is mostly yellowish, and so tough that a nest may be removed without any danger of damaging it, and the silk is so strong that, even when the earth has been dried and wholly removed, it will bear a considerable strain without breaking, and can be drawn over the finger like a glove. Up to this point the burrow possesses no advantage over that of the bird-spider, being a simple silk-lined tube. But the spider now sets to work at the construction of a door, by which the opening may be not only closed but concealed.

Guided by instinct, it weaves a circular web rather less than the diameter of the burrow and works into it a quantity of earth. This process is repeated until the spider has constructed a circular plate of alternate layers of web and earth, nearly twice the thickness of a penny and slightly conical. Eight or ten layers are employed in the manufacture of the plate. A small portion of this plate is attached to the lining of the burrow, the webs, indeed, of the plate being woven into those of the lining and being a continuation of them.

The plate, therefore, forms a door with a silken hinge, and so accurately is it constructed that when it is closed the upper surface is exactly level with the ground. It will be seen, therefore, that the aperture is effectually closed; but there are yet two points in the structure of the trap-door which must be noticed. In the first place, the spider takes care to cover the upper surface with earth exactly resembling the soil in which the burrow is sunk, even imitating the irregularity and roughness with astonishing fidelity, and fixing lichens, moss, or even leaves, on it just as the

chaffinch does on its nest. So perfectly is this done that to discover a trap-door is almost impossible.

Strangers, when sitting on a bank, are often astonished at seeing a circular piece of earth lifted near them, the jaws and legs of a spider partly protruded, and quickly withdrawn when the intruder is seen. So rapidly does the spider pass back again into its burrow and shut the door after it, that the movement has been aptly compared to that of a cuckoo in a clock. Even when the eye has been thus directed to the exact spot, it is not easy to find the door. If, however, it be found, and an attempt be made to open it, a tolerably strong resistance will be experienced. This is caused by the inhabitant, which holds firmly with its forelegs to the door and hind legs to the lining of its web, and resists as long as it can. So firmly does it retain its hold, that when the nest has been pulled out of the soil and torn asunder, the spider has come away with the upper portion, still holding the door against the foe. The marks thus made by the spider's claws may frequently be seen, especially in the doors of old nests, as shown in the accompanying figure.

The second point of interest in the trap-door is the mode in which it is fixed. The spider always chooses a sloping surface for its burrow, and the hinge is always placed upon the highest point, so that when the spider issues forth the door is self-acting and shuts by its own weight.

For our knowledge of the European trap-door spiders, we are mainly indebted to J. T. Moggridge, in whose work * the various species and their nests will be found very completely described and figured. He has roughly classified the nests of these spiders under two headings—namely, the "cork" nests, so called from their tight-fitting, cork-like lids; and the "wafer" nests, in which the lid laps loosely over the opening, and has been compared to a wafer. Amongst the European species, *Nemesia Moggridgii* (named after Mr. Moggridge), found at Mentone, *N. cæmentaria*, and some others, construct nests with "cork" doors. These cork nests all consist of a simple silk-lined tube, with the plug-like door at the top, but many of the wafer nests are more complex.

The simplest form of wafer nest is that constructed by *Neme-*

* "Harvesting Ants and Trap-door Spiders." *(L. Reeve & Co.)*

sia Simoni, being a simple tube down to the very bottom, and differing from the "cork" nests only in the structure of the door. It is found at Bordeaux.

A Neapolitan species (*Nemesia meridionalis*) adds an upward tube, branching from the main tube about half-way down, and rising nearly to the surface of the earth. These nests may be found very abundantly in some places on the hill of Posilipo, near Naples, and also in the island of Ischia. *Nemesia suffusa*, from Montpellier, builds an exactly similar nest.

Certain species found at Mentone and other places on the northern shores of the Mediterranean add an inner door to their nests. Thus, *Nemesia Eleanora* builds its nest with an embranched tube, and with a thick extra door of a circular form, but straight along the hinge and with the upper side slightly concave. This door is inserted somewhat above the middle of the tube, and opens inwards. It resembles cardboard in texture, and attached to it are silken curtains or flaps, which cause it to close firmly, while the tube is slightly widened below the door to permit of its opening freely.

In digging out a very large nest of *N. Eleanora* at San Remo in 1880, M. L. Faulder White discovered about an inch and a half or two inches below the second door a very small cavity or groove (about an inch long) in the wall of the tube, separated partly from it by a silken filament and completely filled with the husks of small red ants. At the bottom of the nest was found the spider, which was unusually large, but no remains of ants (such as are often found) were there. Such a storehouse or larder had never previously been noticed by anyone.

Another Mentone species, *Nemesia Manderstjernæ*, has a nest with an upward branch, and the inner door, whose hinge is attached to the point of junction, is so arranged that when open it shuts up the branch; when closed, it shuts off the whole lower part of the nest. This door is oblong and channelled along its outer surface, and the main tube frequently has an abrupt cavity just opposite the door, so that when the latter is closed this cavity looks very like the end of the tube.

Nemesia congener, found at Hyéres, has a nest somewhat resembling this last, but the inner door is more circular. The

tube is curved while the branch is vertical, and there is never an obtuse cavity half-way down.

The nest of a trap-door spider (*Cteniza nidulans*), found in Jamaica, bears a curious resemblance to a very small yellow stocking, and the likeness is increased by the fact that in most cases the spider does not content itself with a single tube, but makes the last inch or two of the end at an angle just like that of a stocking-foot. The reason for choosing this form is rather doubtful. At one time it was thought that the spider altered the course of the burrow in consequence of coming across some obstacle, such as a pebble or root; but as the bend invariably occurs at the same place, it is evidently intentional and not accidental. This nest appears to be of the "cork" type.

In the British Museum there is a remarkable example of a burrow with two trap-doors—one in the usual place at the entrance and the other an inch or two below it. The reason for this duplicate door was easily discovered. The nest had been made in cultivated ground. Earth had been thrown over the mouth of the burrow and buried it. The inmate had therefore burrowed upwards until it had made its way into the open air and had then constructed a second door.

This nest is essentially different from the double-door nests above described, the inner door opening outwards instead of inwards, and having exactly the same structure as the outer door.

It must be remembered that only the female spiders live in these nests, the males being very rarely found. The young spider, after quitting the nest of its mother, builds an exact copy of it in miniature, and as it grows gradually enlarges its nest. In the wafer-doors the layers of silk and earth, thus added, are visible, but are better seen from the cork doors, and in these they may often be separated.

If the top part of the tube, with the lid, be removed, it will be found, on returning to the same spot in a day or two, that the spider has furnished a new door to the tube. The spiders are nocturnal in their habits, frequently going out at night in search of prey. It is stated that the Californian "cork" spider (*Cteniza Californica*) fastens its door open with a silken thread before leaving its nest, the door being so difficult to open from the

outside. An interesting account of the habits of this species will be found in the *Scientific Enquirer* for May, 1886. The tube of its nest is far shorter than those of the European species, and it is therefore well adapted for observation in captivity.

The greatest enemies of trap-door spiders in Europe are lizards and centipedes, and the spiders are always on the alert to guard against their attacks, so that if the outer door of a double-door nest be opened, the spider immediately slams the inner door to, for fear of its pursuers. If the latter be forced open or removed, the spider will generally flee to the very bottom of her nest, where she will be found crouched up in terror. Owing to the complete concealment which the doors of the nests effect, the only way of detecting them in countries where trap-door spiders abound is to turn up all the likely-looking bits of earth until one of the nests is found. Specimens of the top part of the nest, showing the outer door, may be placed, with the surrounding earth, in cardboard boxes of the proper size, and, after filling the tube with cotton wool, the best plan is to pour in plaster of Paris to a certain height, fixing the portion of the nest and preventing the earth from crumbling. Since the extension of the Parcels Post to most parts of the Continent, a few of these curiosities may occasionally find their way over to England.

THE HESSIAN FLY AND ITS PARASITES.—Observations upon the Hessian fly, *Cecidomyia destructor*, made in North Britain, brought to light the fact that it has not reached our island without being accompanied (or followed) by several of its minute parasitic enemies. Probably, it is in some measure due to the proceedings of these that it has not extended over a larger area in those districts where it first appeared. One of the most curious facts is that these parasites have been verified as occurring chiefly in Russia—at least, four of the species; the fifth has been recorded in America and also in Germany. This rather supports the theory that the recent visitation came to us through imports from Russia.—*Journal of Horticulture.*

A Method of Preparing, for Microscopical Study, the Radulæ of Small Species of Gasteropoda.*

By Charles E. Beecher.

ONE of the early methods employed to obtain the lingual membranes of Gasteropoda was by actual dissection. This process, in many cases, is very laborious and the results unsatisfactory. Advantage was next taken of the resistance of the radulæ to the action of ordinary chemical reagents. The resistance to acids and alkalies induced the early belief in the silicious composition of the teeth, and it is only quite recently that the fallacy has been eradicated from text books on natural history, and from special works on the mollusca. It is now known that the teeth are composed of a substance closely related to chitine. Its behaviour under the influence of the ordinary staining fluids used in microscopical work is quite varied and interesting, and affords some points of comparison with true chitine.

Another method, applied in the study of the extremely small radulæ of minute species of snails, was to crush the animal, and examine the dentition through the translucent tissues. Of course, this plan is in itself not altogether satisfactory, on account of the difficulty of distinctly studying the characters of the lingual membrane. Besides, it was not conducive to the production of clean, beautiful, and permanent preparations, such as ought to be retained, to serve as the types from which descriptions and illustrations have been made, and from which important deductions have been drawn.

When the characters of the odontophore came to be studied, it was first thought that they would furnish a simple means of classification, and an infallible method of determination. At the present time, the best authorities have abandoned nearly all the classifications of the Gasteropoda based upon the characters of this member alone, and give to it an importance about equal in

* From *The Journal of the New York Microscopical Society.*

value to that of the shell. Thus it will be seen that the radula still holds an important position in the study of the mollusca, but is not of the greatest value.

Several of the steps indicated in the following directions for preparing the radulæ of the Odontophora, for microscopical study, and for permanent preservation, have been employed by previous investigators in this department of research; but it is believed that some novel features are here described, and the entire sequence of processes is reduced to a system, which will be found to produce uniform and satisfactory results. At first, I adopted the methods in common use, and found that for the work which I had undertaken—namely, the study of the lingual dentitions of the American fresh-water species of *Rissoidæ*—I could not attain the desired degree of excellence in the preparation of the radulæ, which would enable me to make a complete study of their various features. This led to a long series of experiments, performed with all the principal reagents used in microscopical investigation. An enumeration of these experiments would add but little to our knowledge, beyond the fact that most reagents are useless for this work, and many are of but little value.

When manipulating with such small objects as the lingual ribbons of our *Rissoidæ*, small species of *Planorbis*, *Goniobasis*, *Pupa*, *Vertigo*, etc., simplicity is of the greatest moment, for in transferring the radula from one dish to another, and passing it through successive reagents, it is very likely to be lost, or so mutilated in handling as to be worthless. Therefore, a complicated or laborious method is to be avoided if possible.

The transparency of the objects is also another obstacle to be overcome, and while mounting media can be selected of a different refractive index, yet the loss of absolute and reliable differentiation, from the reflection of light from the polished denticles, the interference of perspective in media of low refractive indices, and the diffraction lines produced by the minute denticles, render it extremely desirable to stain the specimens, and to mount them in a highly refractive medium, or one that nearly agrees with the refraction of the objects themselves.

Method of Preparation.—The shells having first been boiled or placed in alcohol to kill the organisms, the animals are

extracted from their shells by drawing them out with a mounted needle or hook, and in the larger species the head is cut off, and the remainder of the animal rejected. In the minute species, the shell may be removed by hydrochloric acid. Either process may be employed, to equal advantage, upon shells which contain the dried remains of the animals.

The specimens are then placed in a small porcelain crucible containing water, in a sand bath over a Bunsen burner. A little boiling will soon render them in a condition for the rapid action of a small piece of caustic potash, which is next placed in the crucible, and the whole allowed to boil until the tissues have become disintegrated and partially combined with the potash. The action of the potash should not be continued after it has completed its work upon the tissues, as continued boiling will attack the thin membrane, upon which are situated the lingual teeth, and which holds them in position.

After removal from the burner, water is added and the undissolved material allowed to precipitate. With a pipette having a rubber bulb, or by decanting, the fluid is nearly all removed, and clean water again added. This is repeated, until the potash and light flocculent matter are eliminated.

The residue is then washed into a flat-bottomed dish, or large watch crystal, and the radulæ, in the majority of cases, can be perceived by the unassisted eye, and removed, by means of fine, mounted needles, to another receptacle containing a very small amount of water. In case the radulæ are very small, the material is transferred drop by drop, with a pipette, and examined, under a one inch or three-quarter inch objective, on the horizontal stage of a microscope, preferably furnished with an erector. They can then be removed from the mass of extraneous matter, and placed in a separate receptacle, as in the former instance.

A drop of strong chromic acid is added to the specimens, and in from one to two minutes the teeth on the radulæ are stained a light yellow or amber colour. After washing out the chromic acid, the specimens are dehydrated in the usual way, and after removing the alcohol with a pipette, absorbent paper, and partial evaporation, oil of cloves is added, and the specimens are ready for mounting in Canada balsam.

The lingual membranes will be found to be more or less coiled, and usually attached to the jaws. It is desirable, in the mounted specimen, to have the membrane flattened out, with the dentiferous side uppermost, and dissociated from the jaw. Some species have a large, strong jaw, which, if left with the lingual membrane, will raise the cover-glass so far above the denticles as to exclude the use of the higher powers of the microscope. Therefore, some mechanical work is necessary to unfold the radula, and remove the jaw. Having provided a clean glass slide on the turn-table, the specimen is taken from the clove oil and centered on the slide. Now placed under the microscope provided with an erector, and using mounted needles, the radula is easily unrolled with the dentiferous side uppermost and the jaw removed. Replaced upon the turn-table, a thin cover-glass is superimposed and centered. The cover-glass should be put on before the balsam is added, as it prevents the specimen from again becoming coiled or displaced. A drop of balsam in benzole is put adjacent to the edge of the cover, and the slide held an instant over a gas-burner or alcohol-lamp, which will cause the balsam to flow by capillarity under the cover-glass. A small spring-clip is then used to press the cover down and hold it in place. The slide is removed to a drying oven, and left until the balsam has hardened, so that the portion outside the cover can be scraped off. The slide is then cleaned by washing in strong alcohol, using a piece of soft tissue paper to rub it dry. It is quite essential to use cover-glasses of known thickness. Many radulæ require a one-tenth inch objective. The convexity of the object, combined with the thickness of the cover, necessitates the use of very thin glass. For the *Rissoidæ*, I have usually employed glass of ·004 inch thickness.

Movement of the Earth's Surface.—At the equator, a point on the earth's surface moves rather more than 1,000 miles an hour; in latitude 45 deg., north or south, the rate of motion is about 750 miles an hour. London is carried round the earth's axis at the rate of more than ten miles per minute.

Smut of Wheat, Oats, and Barley.*

Ustilago carbo. Tul.

EVERY person, even the most unobservant, who has walked through a field of wheat, oats, or barley, must have noticed smutted ears. Instead of the healthy spike or panicle of grain being presented, a sooty, ragged mass of black dust and scales is seen surmounting the fruiting stems of the corn. In some places the disease is called "chimney-sweeper," in others "black ball," "dust-brand," or "smut." In certain districts it is erroneously termed "bunt," which is a totally different disease of corn. The black powder is produced in such profusion that it is impossible to gather a few diseased ears without the hands being soiled as if with soot. We have heard smutted ears called "the male flowers of corn" by some country folk, the erroneous idea being that these diseased ears are the male, or the black pollen-bearing plant. Some districts are more liable to Smut than others, although none are free. The disease is sometimes extremely destructive, especially in oats. In some instances nearly the whole crop becomes smutted, and in bad cases from one-sixth to one-third of the crop is destroyed. When smutted wheat is ground with sound grain, it not only seriously discolours the flour, but it injures it as food. Straw infected with the black powder or spores of the Smut fungus is disliked by cattle, and it is an offensive adjunct to chaff when given in food to the animals of the farm.

The Smut disease of corn is caused by the presence of a fungus which exists within the tissues of the plant, grows with the growing stem, and at last bursts from the inside of the plant outwards at about the time when the corn is reaching maturity. The name of the fungus is *Ustilago carbo.* The name is derived from *Ustio*, which means a burning, and *carbo*, which means charcoal—the compound name of the fungus having direct reference to the burnt and sooty appearance of the parasite.

We will now make a close examination of the extremely curious fungus which causes Smut, and show how it invades the

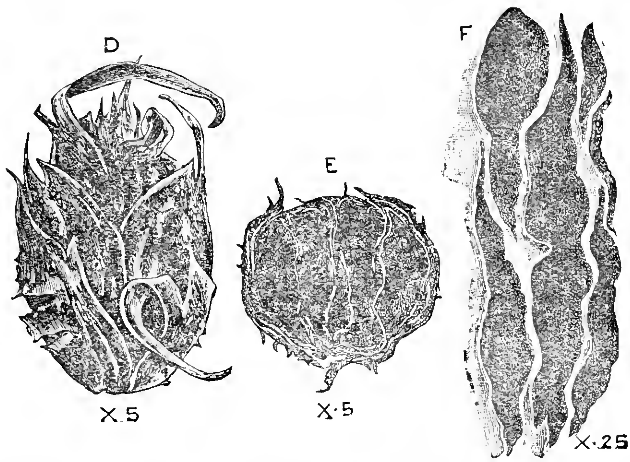
* We are indebted to Messrs. Webb and Sons, of Wordsley, for this paper and for the excellent engravings with which it is illustrated.

corn. If we take smutted ears of wheat, oats, and barley, and examine them without a glass, we shall see them as at *A*, *B*, and *C*.

THE SMUT FUNGUS.—*Ustilago carbo*, Tul., in *A*, *Wheat*; *B*, *Oats*; *and C*, *Barley*.

The first point to be specially noted in the field is that every ear which springs from one root will be smutted. This fact indicates that the disease springs from the base and runs up every stem from the ground line. If further proof of this method of growth is needed it will be seen that the lowermost part of each ear is the part that first shows the disease. It is common to see the bottom of an ear of wheat or barley, or a panicle of oats, badly smutted and the top sound. The disease in these instances has not yet reached the top of the plant; one never sees the top of an ear diseased and the base sound. It is an undisputed fact that in Smut the disease grows inside the stem from the bottom upwards.

We will now take a dwarfed and diseased cluster of grains and chaffy scales from a wheat-spike and magnify with a lens five diameters. We now see it as at *D*. The chaffy scales are rent and torn, and from every fissure the fine sooty powder is seen bursting out. If the cluster or spikelet is cut across as at *E*, it will be noticed that the whole farinaceous material of the interior has been replaced by one compact mass of fine black dust. The upper part of the stem of the corn, and the scales and grains

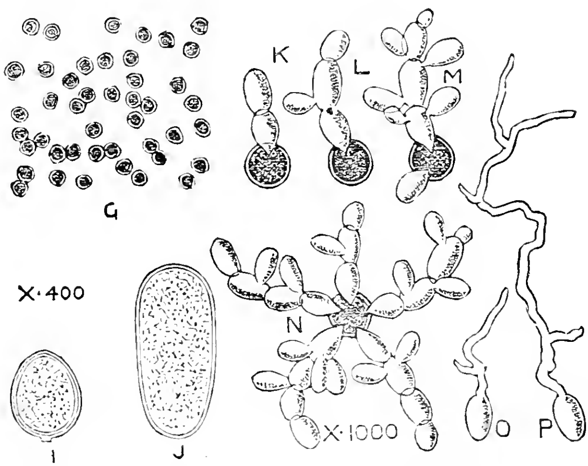


Spikelet of Wheat (D) and transverse section (E) invaded by the Smut fungus, enlarged 5 diameters. Disease pustules of ditto, enlarged 25 diameters.

alike, are infested and choked by the sooty powder. If we take a fragment of one of the chaff scales, and magnify it with a microscope 25 diameters, we shall see numerous cracks, some large, others small, as at *F*, and from every crack the fine jet black powder will be seen bursting out from the inside.

Every grain of this black powder is an inconceivably minute spore or seed of the Smut fungus. In an early stage of the disease, in a state seldom noticed by farmers, the fungus is colourless; it grows within the stems of corn as fine transparent threads, immeasurably finer than any spider's thread. These threads at length reach the ears, the scales, and the infant grains. Here they form within the substance of the plant a whitish viscous mass of

threads and cells, and this mass at length gives rise to an immensely large number of spores, which quickly become black in colour, burst through the tissues, and so reach the outside air. The fungus always grows so luxuriantly in the ears that nothing is ultimately left of the part which should bear the grain but a few dry vegetable threads, which are speedily torn apart, and this wreck of what should be the ear is soon carried away by the wind. As a rule, the ears, whether of wheat, oats, or barley, are totally destroyed by the fungus.



The spores or seeds of the Smut fungus (G) enlarged 400 *diameters: other fungus spores enlarged to the same scale at I and J: and Smut spores germinating, enlarged* 1,000 *diameters.*

The particles of the black powder are excessively minute in size. If they are magnified 400 diameters, they are seen as at *G*. An idea of their extreme smallness may be gained by comparing them with a seed or spore of the potato fungus, illustrated to the same scale at *I*, or with a seed or spore of the putrefactive mildew of onions, shown to the same scale at *J*. Two hundred of the spores of the Smut fungus could find ample room inside a single spore of the onion fungus, *J*, named *Peronospora Schleideniana*. Owing to their extraordinary smallness, the spores of the Smut fungus find their way everywhere; they are

also produced in such profusion that in a smutted district there is not an inch of ground free from them.

The spores of the Smut fungus, on germination, of course reproduce the disease in cereals. They do not germinate on dry ground or in dry air, but will retain their vitality, if kept dry, for at least a year. We have kept smutted ears in papers for a year in a dry room, and at the end of this time the spores of the fungus have been found to have suffered no injury. The spores, like ordinary seeds, require moisture for germination, and if they are put in a film of water they will germinate in from six to twelve hours. The very highest powers of the microscope are required to see this germination, and if objectives are used which magnify one thousand diameters, germinating Smut-spores will be seen as at *K*, *L*, and *M*. On germination, the outer coat of the spore bursts or cracks, and out of the fissure a minute transparent bladder emerges, which by budding soon gives rise to a second cell or bladder, as at *K*. As growth is continued, further budding takes place, at right and left, as well as at the top of the buds, as shown at *L* and *M*. If the spores are grown in the juices from farmyard manure diluted with water, the budding becomes much more profuse, as at *N*. This bursting and budding of the minute spores, which can be observed under the microscope, takes place naturally in the ground in damp weather, and the purplish black Smut-spores give place to innumerable quantities of these excessively small, transparent, spore-like bladders.

It is a remarkable fact that these buds from Smut-spores cannot be distinguished under the microscope from yeast. They are capable of growing and multiplying for an indefinite period of time in this yeast condition. Yeast is of course a fungus, and observers are not wanting who say that germinated Smut-spores are not only like a yeast, but they are positively yeast itself. Whether this idea is a correct one is somewhat uncertain, but the fact remains that yeast and germinated Smut appear to be identical. Both excite alcoholic fermentation. Smut-spores which have germinated in our fields lead a non-parasitic life in and on the ground. It is remarkable that the yeast-like buds from Smut-spores are not only capable of producing a vast number of other yeast-like buds, but some of these buds, probably influenced by

external dry or other conditions, produce, on germination, extremely fine attenuated threads, as illustrated at *O* and *P*. These attenuated threads are also produced on and in the ground, and they secure access to cereals in the following manner :—

After the seeds of wheat, oats, and barley have been planted, the first green leaf from the seed speedily appears above the ground. In order to perform its vital functions, every leaf is furnished on its under surface with an immense number of minute orifices, which lead direct to the inner substance of the leaf. Through these little openings (termed stomata), the plant parts with moisture in the form of fine vapour. In damp weather every little opening or mouth stands naturally wide open. At the same time, the yeast-like buds belonging to the Smut-fungus are protruding their fine threads, as at *O* and *P*, upon the ground. These threads come in contact with the first young leaves of cereals, and enter amongst the tissues of the infant plants of wheat, oats, and barley by the minute open mouths or organs of transpiration belonging to the back of the leaves. When the fine Smut-threads are once within the substance of the young cereals, they are in their natural position. They speedily find their way to the young stems, and, as the stems grow, the fungus grows too, and is carried up by the growing stems. When the ear or panicle is formed, all its parts, including the finest stalks, are invaded by the fungus, and in these parts of the plant it matures itself and produces its innumerable black seeds or spores which burst through the plant from its apex, and from this position once more reach the air and the ground.

It may be noted that the fungus can grow on no other plants except cereals and grasses.

The Smut-fungus grows on a considerable number of wild grasses, in waste places, such as darnel and the various wild oat, barley, and rye grasses.

New Photo-Micrographic Apparatus.

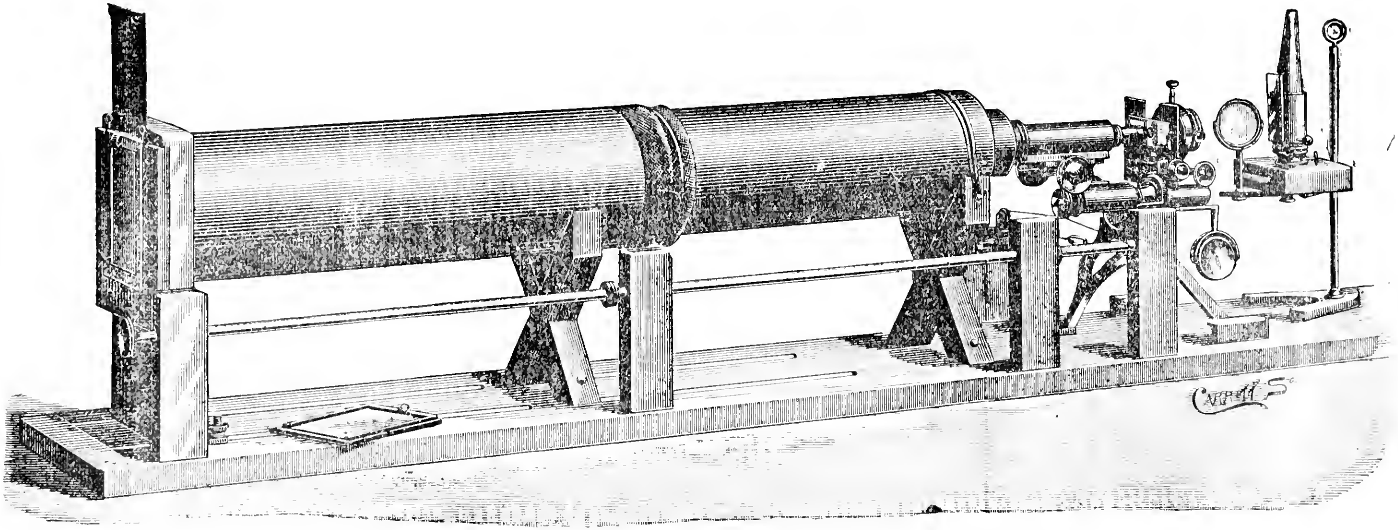
By C. Lees Curties.

THIS apparatus consists of a base-board of sufficient length to take the camera when fully extended, the microscope, and the lamp, and is an inexpensive form of camera, designed by Mr. E. M. Nelson and myself, for use specially with Zeiss's new projection eye-piece, No. 3; but can also be used with ordinary eye-pieces, or where a long camera is required, without eye-piece.

The height of the camera above the base-board is the same as the optic axis of the Nelson model microscope, but can be arranged to the height of any microscope stand. The camera itself consists of two millboard tubes, which are light but strong, the one sliding into the other like the tube of a telescope; the joint between the two tubes is made light-tight by a velvet flap. Whe the tubes are closed, the length of the camera is 2 feet, but it can be used at any length up to 3 feet 6 inches. The outer tube is fastened to an upright frame of wood, which is clamped to the base-board by thumb-screws at any point of its extension; this tube is removed when the different sized diaphragms are put in position.

The focussing screens of grey glass and plane glass, with finely ruled diamond lines, slide in grooves at the back of the wood upright; a double metal back is supplied which also slides easily in the same grooves. The focussing is effected by a rod placed at the right hand side of the camera, a string passes round this, and over a wheel on the opposite side, taking a turn round the milled head of the fine adjustment. This string is kept tight by a strong elastic band. The feet of the microscope fit into blocks fastened on the base-board.

The manner in which the apparatus is used is as follows:—The camera is closed up and pushed back as far as possible. The microscope is then arranged in a horizontal position, with the feet held firm under the blocks on the board. Sufficient room is left between the eye-piece and the opening in the camera to allow the eye of the operator to be placed to the eye-piece. The illumination is now centered and adjusted, and the image of the object



THE NELSON-CURTIES PHOTO-MICROGRAPHIC APPARATUS.

viewed with an ordinary eye-piece. Having completed the adjustment, the eye-piece is removed and a projection eye-piece inserted. The camera is now slid up to its place, but leaving enough room for the fingers to adjust the eye-lens of the projection eye-piece. This is moved until a sharp outline of the diaphragm in the eye-piece is produced upon the grey glass screen or upon a piece of white paper held near the end of the camera. The camera is now pushed up until the front tube enters the light-excluding cap fitted on the microscope tube, and then extended until the desired size of the picture is obtained. The object should now be accurately focussed upon the plate-glass screen, a good focussing glass, of course, being used.

A very good method of judging exposure is given in Mr. E. C. Bousfield's "Guide to the Science of Photo-Micrography," with table for use in conjunction with Warnerke's sensitometer.

ARTIFICIAL SERUM.—An improved formula for artificial serum may prove useful to those who make daily examinations of the blood. Dr. Mayet, of Lyons, who is himself an expert microscopist, recommends the following composition:—Distilled water, 100 grammes; anhydrous phosphate of sodium, 2 grammes; sugar, *q.s.*, to bring the solution up to sp. gr., 1·085. This liquid appears to be an excellent medium for preserving blood-corpuscles and other globular anatomical elements without alteration for a considerable time, so that they may easily be counted and examined under a high power in anæmia, leucocythæmia, etc. Owing to the density and slight viscosity due to the sugar, and the preserving action of the alkaline salt, the different elements are prevented from adhering together, and remain thus equally distributed in the fluid.

POTASSIUM CYANIDE VAPOUR.—It is a mistake to suppose, says the *Scientific News*, that the vapours given off by potassium cyanide are deadly to all animals. We have seen several species of beetles which, after prolonged imprisonment along with abundance of this chemical, came out quite safe and sound.

The Microscope and How to Use it.

By V. A. Latham, F.R.M.S.

Part XIV.

Practical Notes on Histology.

Special Methods for Examination of the Spinal Cord, Brain, etc.

THE great difficulties experienced by all investigators of the nervous system have been chiefly fourfold :—

(*a*) That of becoming acquainted with the various methods which lie so very scattered amongst the numerous scientific periodicals.

(*b*) That of cutting sections of an entire human brain, or large segments of it, of sufficient delicacy for microscopic purposes, and with almost mathematical accuracy.

(*c*) That of retaining large masses of hardened nerve tissues in absolutely the same condition as during life, without shrinking or rendering the tissue friable.

(*d*) That of demonstrating the dark fibres with such clearness that they can be traced throughout a great part of their course with ease and certainty. All who have worked on the nervous system know how great these difficulties are, and how much we need some process by which they can be overcome.

The great obscurity and errors which prevail in regard to the normal and morbid anatomy of the nervous centre is, no doubt, mainly due to these causes. The methods here given are those which have proved of greatest use to me during the examination of these organs, and I sincerely hope they will not be without value to other experimenters.

General Method.—This investigation is a long and complicated one, the tissues having to pass through the following stages in the order given :—

I., Hardening ; II., Cutting ; III., Staining ; IV., Mounting ; each stage claiming its own special process.

I. Hardening the Tissues.—Cut into small pieces, place them in methylated spirit, and let them stay for about two days

(sometimes 24 hours will suffice), to ensure them against subsequent decomposition. If the brain is the subject of research, leave it for from four to six weeks to *harden* in the following solution :—Chromic acid, 1 part; bichromate of potash, 2 parts; water, 1,200 parts. If the *spinal cord*, then 1 part of the acid to 200 of water in the case of the human or large animal subject, or 1 to 400 proportion in that of a small animal, will be sufficient to induce the requisite induration. [Do not exceed the above-named period of immersion, as the action may change and ruin the specimen. Should you wish to defer your investigation, keep the specimens in methylated spirit until ready to proceed with them.]

II. Cutting.—A mixture of 1 part of lard to 5 of paraffin, having been heated in a water bath, is poured into a microtome or a tin or paper box (see *Journal of Microscopy*, Vol. VI., p. 242). Now, having first steeped your specimen some ten minutes in absolute alcohol, hold in forceps and dip gently into the embedding mixture for a moment, withdraw to prevent shrinkage, and then replace and hold it until the mass begins to cool. Then, with a razor, kept wet in methylated spirit, (or absolute alcohol if you desire very fine sections); cut sections, sweeping obliquely from right to left across the top of the microtome, taking care to remove each slice in one sweep. Transfer sections *seriatim* to water (or spirit), removing the adhering paraffin, if any, by moving them circularly with a small-hair brush; then pour off the water or spirit. Having washed them, leave for some thirty minutes in a solution of 1 part bichromate of potash to 100 of water; then proceed to stain and mount in the ordinary way.

Variation from above rules :—

Freezing has been successfully used in preparing brain, etc.; after staining in carmine mount in a mixture of hydrochloric acid, 2 minims, or glacial acetic acid, 5 minims, added to glycerine, 1 oz.

Sections of spinal cord should be taken from all the various regions, and hardened in a solution of ammonia bichromate (2 or 5 per cent.) solution for from a week to a month, according to what strength of solution was used; transfer to spirit and cut. Stain sections in eosin, carmine, hæmatoxylin, lithium-carmine. Anilin blue black, 17 per cent. solution stains the ganglion cells

very well, and a double stain of eosin and hæmatoxylin is excellent.

Dog.—Some sections should be made as soon as the cord has been hardened in the Erlicki's fluid, before placing the cord in alcohol, in order that they may be stained in osmic acid; others I find give good results if the sections be placed in 0·5 per cent. methyl green for 12 hours; wash well in distilled water, then place in borax carmine. This shows the axis cylinder and ganglion cells red, whilst the neuroglia comes out violet, the remainder green. Erlicki washes his sections for two hours in distilled water before staining in ammonia carmine.

Horse.—Get some short transverse sections and place for forty-eight hours in Ranvier's alcohol. Then snip pieces out of the anterior horn of grey matter, place in 2 per cent. solution of picro-carmine for twelve hours or so, then tease the multipolar nerve-cells out with needles and mount in Farrant, in a shallow cell.

To harden Spinal Cord and Brain in Erlicki's Fluid.—It takes about ten days, but will do so in half the time if we care to take the trouble to keep it at a temperature of about 40 deg. C. or 104 deg. F. It must be fresh each time and filtered before use. It must be changed daily or nearly so, and when the tissues are hard enough the fluid is washed away with tap water and the tissues finished in alcohol, commencing with 75 per cent.

Spinal Cord (Overlach's Method).—Place small pieces of the spinal cord of a child in a 1 or 2 per cent. solution of ammonium bichromate until hard (fifteen to twenty days) in a cool place. Make sections, and place in a solution of chloride of gold, 1 part, and potassium in 10,000 parts of water, which has been acidulated by the addition of a few drops of hydrochloric acid. Then wash in one part of hydrochloric acid in 2,000—3,000 parts of water; then transfer for 10 minutes to a mixture of one part of hydrochloric acid in 1,000 parts of ordinary alcohol; then successively in absolute alcohol, oil of cloves, and Canada balsam. After three or four hours the nerve network is visible.

Krause's Method.—Hang fresh cord in a cylinder full of Müller's fluid. Attach a small weight to the lower end to avoid torsion. After twenty-four hours, change Müller for 1 per cent. of

chromic acid, which is changed for fresh on the fourth day. A few days later (when the cord appears hard), the chromic acid is removed by means of water and the cord put into spirit, followed by absolute alcohol, which must be twice changed. Now imbed in paraffin; pass sections either (*a*) through alcohol, carmine, oil of cloves, into Canada balsam; or (*b*) simply through benzole or Bromier's "Flochwasser" and Canada balsam. ("Flochwasser" appears to me to be a preparation of xylol.*)

Bichromate and Silver Nitrate Process.—This is sometimes spoken of as Golgi's method, and is taken from a paper of Rezzonico, a pupil of Golgi.†

1.—Take pieces of perfectly fresh spinal cord and soak them in a 2 per cent. solution of bichromate of potash for a varying period, according to temperature. (In summer eight to fifteen days may suffice; in winter about a month is necessary.)

2.—Wash them, put in a 0·75 per cent. solution of nitrate of silver. Time varies according to temperature. In summer the reaction is complete throughout the tissues in two or three days; in winter, eight to ten days.

3.—Dehydrate small pieces in alcohol (make sections if necessary), clear in oil of turpentine. Tease while in the turpentine and mount in dammar.

4.—Leave preparations to themselves, in order that the secondary impregnation may take place. In direct sunlight, eight or ten days; in diffused sunlight, twenty to forty days will be required. Greater certainty is obtained by treating the fresh tissues with osmic acid (by means of interstitial injection) before putting into bichromate. In this case, a much shorter immersion in bichromate will suffice (four to eight days).

By this method may be seen, in the medullated fibres of the spinal cord, a chain of conical funnels, set one within another, embracing the axis cylinder with their narrow aperture, etc.

Xylol for Central Nervous System (Merkel's Method.*)—Dehydrate sections from system with 94 per cent. of alcohol, in which they should remain ten minutes at least; then clear with

* "Archiv. für Mikros. Anatom." (1887).

† "Archivis par le Scienze Mediche."

xylol, in which they are examined. I think this method, perhaps, the most superior of all for studying distribution of nerve-fibres. Unfortunately, they are not quite permanent, though, if mounted in Canada balsam, they last for some length of time. They may, however, when they become so transparent as to be of no further use, be *re-prepared* by putting back into alcohol and thence in the xylol.

OBITUARY.

The late Dr. Asa Gray.

DR. ASA GRAY died at Boston, in Massachusetts, on the 31st January last. By his death the world has been deprived of one of its most able botanists. He was born in the year 1810, and shortly after taking his doctor's degree in Fairfield College, he began those studies to which he has devoted the remainder of his life. Dr. Asa Gray became known to European botanists soon after the publication of his admirable "Text-Book on the Structural and Morphological Botany of Phænogamous Plants," in the year 1842. The fifth edition of this much-esteemed work appeared in 1857, since which date the name of Asa Gray has been on the lips of botanical students in almost every country where the English language is spoken and the science of botany taught. He was an occasional visitor at Kew, where he is said to have profited by the study of the magnificent Herbarium, which Sir Joseph Hooker has done so much to enrich.

On one occasion he accompanied Sir Joseph Hooker on a botanical trip across the American Continent. Dr. Asa Gray has done excellent service to the botanical world in the preparation of that great flora of the United States, which, we believe, is still incomplete. In 1861 Dr. Asa Gray gave to the scientific world another admirable work, in which he dealt fearlessly with the late Charles Darwin's treatise on "The Origin of Species." He may fairly be classed with Hooker, Lyell, and Huxley as one of the chief English-speaking commentators on our great naturalist's

best-known work. For at least half a century he has been the highest authority, the practical dictator, of American botany.

Few men have left this world leaving more friends and less enemies. Always genial and courteous, he possessed the happy talent of expressing a difference of opinion without giving offence, much less making an enemy of his opponent, and that in a country where acrimonious disputes are at least quite as common as in Europe. An excellent teacher and writer of text-books—which are almost as much used in this country as on the other side of the Atlantic—he was for many years on the professional staff of Harvard College, at a time when such eminent teachers as Agassiz, Wendell Holmes, Longfellow, and Lowell filled similar positions in other departments. The Royal and Linnæan Societies conferred on him the rare distinction of their Foreign Membership. Few losses to science that have occurred within recent years will be more felt than that of this truly excellent botanist. His works will live in the recollection of many, and his indefatigable industry, ability, and generosity will, it is hoped, serve not only to keep his memory "green," but to encourage others to follow him in his peaceful and pleasant paths.

Selected Notes from the Society's Note-Books.

PLATE XII.

Aspidiotus Nerii.—These insects are very interesting. I believe these scale insects are Aphides. If so, their being viviparous is no matter for surprise,* since it is the usual manner in which the *wingless form* of insects is reproduced.

I have drawn one of the young specimens of *Aspidiotus*. All its limbs are plainly seen—the antennæ, the mouth, and the six

* The contributor of this slide says:—" I add a slide, *Aspidiotus Nerii*, from oleander leaf, mainly interesting for containing a young specimen, born, as far as I could discover, while mounting in balsam. The legs are clearly discoverable in the young specimen, but difficult to trace in the mature insect. I presume they are viviparous."

legs. I can detect no separate head, nor any eyes. The mouth is of the usual Aphis type. I would draw attention to the two little tubes, or what appears to be the representatives of such, situate at the end of the abdomen, which ants are in the habit of "milking" in rose and other Aphides for honey-dew.

One of the most interesting features in these specimens is the distinctness with which the trachial system can be seen. In the specimen drawn, the air has been expelled from the main trunks, and I cannot by any means see them, but they are visible in two of the other specimens. I am uncertain whether three spiracles on each side is the right number, but I cannot detect any more.

H. M. J. Underhill.

Rice-Paper.—Chinese rice-paper (so-called) is now known to be prepared from *the pith* of a shrubby tree, *Aralia papyrifera*, which grows chiefly in the forests and on the hill-sides of Formosa, attaining a height of from 12 to 14 feet, and propagating itself by suckers thrown up from the roots, like the bamboo. The leaves are large, from one to two feet long, and even more in their greatest width, palmate, with five to seven digitations, dark-green on their upper surface and downy white below. Their foot-stalks and the unexpanded leaf-buds are thickly covered with a brownish down, which easily rubs off, and which consists of stellate hairs. Large drooping panicles of greenish flowers rise above the extremities of the stem and branches, giving the tree a very handsome effect, and its general appearance is said somewhat to resemble that of the castor-oil tree. The young suckers are transplanted by the Chinese, first, into pots, and then into ground prepared for them, where they are carefully tended till the plant is fully grown. They are then cut down, the branches removed, and the stems left to soak for some days in running water to loosen the wood and facilitate the removal of the pith. This, after being cleaned, is cut into cylinders of convenient length and passed on to the paper-cutter, who, taking a sharp, broad-bladed knife, makes a slight longitudinal incision in the cylinder, which is then turned round gently and regularly on the edge of the knife till the whole available material is planed off in thin, even slices. Much care and dexterity are required to produce sheets of even thickness. On these sheets, as is well known, the Chinese execute admirable drawings and paintings. They are also extensively used in the manufacture of artificial flowers, and are so cheap that at some places 100 sheets—each about three inches square—may be bought for three half-pence. The plant has been introduced into New South Wales, where it thrives well, and propagates itself freely in the open air. It has also flowered fre-

quently (under glass, I presume) in the Royal Gardens at Kew.

J. H. GREEN.

Section Yellow Cam Wood is wood of *Baphia nitida*, a tree growing in Sierra Leone to the height of forty or fifty feet. About three or four hundred tons are annually imported. It is of a deep *red* colour, and yields a brilliant but not permanent dye, and dyers use it in the same way that they do the dye of another species of the same genus, Brazil wood. There is a beautiful plate of *Baphia nitida* in "Bot. Cat.," Vol. IV., p. 367. The flowers are yellow and somewhat similar to our yellow laburnum; hence its name (I suppose), *Yellow* Cam wood. The same wood is sometimes called Bar-wood in commerce. E. E. JARRETT.

Aspidiotus Nerii.—If the scale is removed from the leaf when it is just beginning to harden, it will be found to be full of eggs. It is a very beautiful object to see something like 200 eggs of a rich brown colour all closely packed together. At this point the legs of the parent are still visible, and may be noticed slowly moving backwards and forwards, while the whole of the internals seem to have become eggs. A little older specimen of scale will show the nest or back of the parent full of living young, whose first business is to eat up the parent's legs, and then go off exploring on their own account. There are, I think, always some few eggs not hatched, which is probably owing to the loss of heat through the final decease of the parent and the emptying of the body caused by the roving of the rest of the family. If undisturbed, the young seem to stay about the old "home" for a day or two, until they have lost all traces of the downy "packing," which always adheres to them at first.

If any member is troubled with his gardener's negligence about cleaning off the scales, let him show the inside of a good hard specimen, under a pocket-lens, to him. It will have more effect than an hour's talk. (This recipe is recommended after trial.) There are two red eye-spots on the young when hatched, but I do not think they are of any practical use. The head is not particularly marked off from the body, so far as I have been able to make out. H. R. BOULT.

Tingis hystricellus.—With this slide I enclose a cutting from *Science Gossip*, 1869:—

"This new and very interesting hemipterous insect, to which I have given the name of *Tingis hystricellus*, was discovered in Ceylon and collected from the Bringall plant by Mr. Staniforth Green, a gentleman long resident in that island. All the species of the genus to which it belongs are small, but the present species

is exceedingly minute; the largest of the specimens I have yet seen scarcely attaining to one-eighth of an inch in length. When examined, however, in the microscope, it is an elegant insect, and, properly mounted as an opaque object, it makes a fine binocular slide for the low powers. Very little appears at present to be known with respect to its habits and economy.

"Mr. S. Green says:—'It is common here, and hundreds of examples may be found upon a single plant. Those I now enclose were dried between the leaves of a book, and afterwards exposed for a couple of hours to the direct rays of a hot sun. All I can say of its habits is that it sticks close to the under side of the Bringall leaf, and there undergoes all its changes, from the larval to the perfect state. The larvæ are black.

"*Tingis* is a genus of Fabricius, described in the 'Systema Rhyngotorum' (p. 124). Various species of *Tingis* are found nearly all over the world. In the cabinet of the British Museum may be seen specimens from England and France, some of them nearly as small as the species here figured; as well as several from Africa, North America, and the Philippine Islands. Other species are found in Sweden, and in fact all over Europe. A large number inhabit South America, and four or five have been taken in the island of Ceylon. The distribution of the genus may therefore well be called 'world-wide.' The character which at once distinguishes the *Tingis hystricellus* from all other known species of the genus is the complete armature of spines, which project from various parts of the head, thorax, and elytra. Each of these spines, when examined by a somewhat higher power, is found to have a sharp point or seta, projecting as from the open end of an investing sheath. The integument of the elytra, as well as that composing the dorsal surface of the thorax, appears like a thin membrane nearly as transparent as glass, supported by a strong reticulation bearing the spines, which radiate in every direction. The metathorax extends far backwards, simulating, as it does in many allied genera, a large-pointed scutellum. The pupa is exceedingly interesting, being of a dark brown colour, and covered with white spines; those along the sides of the abdomen are compound or branched, and each branch has a projecting seta. These compound spines are not found on the imago insect.

"Some of the species in the cabinet of the British Museum are very beautiful, not only in form, but in colour. They all show a tendency to a reticulated structure of the elytra; but the present species differs from all of them in the quantity of spines bristling over the dorsal surface. It is, in fact, a little insect porcupine, and fully justifies the specific name of *hystricellus*."

This object should be viewed with the paraboloid.

THOS. CURTIES.

English Tingis more resembles the American *Tingis ciliata* than the one described above. The open structure of the cephalothorax appears to be very similar to the so-called "eyes" of ixodes, but which in this case are certainly not organs of vision. It would appear to be a provision of Nature for giving *strength* and *lightness* in structure. H. E. FREEMAN.

Tingis.—Stephens, in his list of British insects, names no fewer than 16 varieties. C. F. GEORGE.

Palatial Tooth of Fish (Fossil) probably belongs to the *Strophodus*, a genus of shark frequent in the oolites. The tooth is a flat plate adapted for crushing the shells of molluscs, on which the fish probably feed. It is made up of a great number of minute toothlets, welded together into a flat plate, in the same way that a horse's hoof may be considered to be made up of a number of hairs. The multiple pulp-cavities are seen in cross-section, each surrounded by an area of clear material, and sending off a cluster of branched, dental tubules larger than those of mammalian teeth, and not, like them, pursuing a parallel wave-course.

H. F. PARSONS.

Section of Screw Pine (Pl. XII, Figs. 3 and 4).—As Mr. West has not figured this, I have tried to supply the deficiency. The endogenous structure is very well seen, and I think that the apparent increase and approximation of the woody bundles towards the periphery (*not* seen in the drawing) is evidence of the fact stated by Smith, p. 88, that these bundles, in the lower part of their course, pass in curved lines outwards from the centre towards the circumference of the stem. What is the colouring matter with which so many of the cells are filled? In the *Intellectual Observer* for February, 1868, there is an article by John R. Jackson, curator of the Museum, Kew Gardens, "On the *Pandanus* and its Allies," in which he points out that they partake, on the one hand, somewhat of the habit of palms—viz., in their foliage; while they incline to exogens in their manner of branching. They are natives of the tropical regions of the Old World, occurring but rarely in America. Some of them are furnished with numerous aerial roots, as seen in Fig. 4 in the Plate (from Smith, p. 61).

The following is Mr. Jackson's account of *Pandanus odoratissimis*, which I take to be synonymous with odourous. He says:—"It is a plant some twelve or more feet in height, with spreading, irregular branches and closely-imbricated leaves, arranged in three spiral rows round the ends of the branches. It grows in the

islands of the Pacific Ocean, China, and the East Indies, being common along the banks of the canals and backwaters of Travancore, where it is planted for the purpose of binding the soil. The long leaves are full of tough fibres, which are used for making cordage of various thicknesses, as well as for making hunting-nets and the drag-ropes of fishing-nets. Matting of all descriptions is likewise made from them. Some of the sleeping-mats, which are dyed or stained of various colours, are fine specimens of native plaiting. The leaves are likewise used to make umbrellas, and they are said to furnish excellent materials for paper-making. The fibre from the leaves is commonly used in Tinnivelly when mixed with flax for making ropes. The aerial roots are applied to a variety of purposes in India. Manufactories exist in some localities, where hats, baskets, mats, etc., are made from them. On account of their light, spongy nature, they make excellent stoppers for bottles in lieu of cork, and the more fibrous part, when beaten out and the pulp removed, is used for brushes for whitewashing, painting, etc. The roots are used medicinally by the native practitioners, and an oil prepared from them has the repute of being a cure for rheumatism. The flowers are odoriferous, as the specific name indicates. Besides the numerous uses already mentioned, the inner or pulpy part of the drupes is eaten as an article of food in times of scarcity."

One can easily understand, on looking at the close texture of the woody bundles, whose cut ends are seen in the slide, what strong fibres they would make when ravelled out for the various purposes enumerated. A. Hammond.

Section of Jaw of Mole affords a good example of mammalian teeth. The fangs of the teeth are here seen in cross-section embedded in the jaw-bone. In the centre of each is the pulp cavity; then the dentine with its radiating tubules; external to this the cement, filling up the interval between the tooth and its bony socket. A set of ramifying canals is seen traversing the bone to convey blood-vessels and nerves to the teeth. The bone has, however, no Haversian canals to convey blood for its nutrition, being so thin that sufficient nourishment can percolate into it from the outer surface through the canaliculi. H. F. Parsons.

Foraminifera and Sea Soundings should not be mounted in balsam. Opaque mounting is by far the best. The mounting as transparencies destroys largely the power to clearly discriminate the species, the whole appearance of the shell being so much altered, and the examination as an "opaque" being all but impossible. C. Elcock.

Spinnerets of Spider (Pl. XII., Fig. 5).—These are from an Epeira, most likely the common garden spider. It is with the first pair of spinnerets, *a*, *a* (there is a slight depression in the cushion of the spinning-tubes, giving each of the spinnerets the appearance of being double), that the spider spins the radii of the web, the threads of which are not sticky. The circular threads which are *not* sticky are spun by the little pair of spinnerets in the middle, which I call the second pair, *b*, *b*. These non-viscid circular (or, more properly speaking, "spiral") threads are not found in a finished web, except in the little patch in the middle. The *sticky* circular threads are, I believe, spun by the third pair of spinnerets, *c*, *c*, but this stickiness is not due to anything peculiar in the construction of the spinnerets, which are identical in those spiders which spin no sticky threads at all. I cannot say what makes a spider's web sticky. My conjectures on this point will be found in *Science Gossip*, 1874. H. M. J. UNDERHILL.

Section of Tongue.—The papillæ are of three kinds—*filiform*, *fungiform*, and *circumvallate*. The latter are only found at the root of the tongue. The *filiform*, as named from their shape, are of small diameter in comparison with their length, and are supposed to have to do with the tongue merely as an organ of touch. The *fungiform* are much larger and fewer in number, and are found chiefly on the sides and tip of the tongue; they are concerned (hypothetically) in the sense of taste, as are also the *circumvallate* papillæ. E. C. BOUSFIELD.

Onosma tauricus (see page 47), natural order, *Boraginaceæ.*—Thanks to a host of patient botanists, we have a wonderfully full account from their general point of view; but it remains for micro. workers to investigate thoroughly from theirs such micro. peculiarities as the plant within its limits may possess. As yet, it seems to me that they have only recognised that many plants of this group have a central hair, at whose base lie certain cells, in such prominence of development from their kindred contiguous cells in the cuticle as to attract attention, and when these are disposed in a stellate or rosulate group, and so form an object of striking beauty, they pass into acceptance and record among what are popularly called micro. objects. Such basal cells are certainly a peculiarity to many plants of this natural order, although not confined to it. The finest and most beautiful example of them I ever saw was on a leaf of *Borago verrucosa*, a native of Arabia; and it is rather odd, that the finest specimens of oil-glands were also on an Arabian plant, *Origanum nervosum* (a labiate), but I do not know where to procure either plant.

Of Onosmas, besides the well-known *O. tauricum*, there are in

cultivation eleven hardy and three half-hardy species, all herbaceous perennials, with mostly yellow flowers. They are entirely propagated by seed or division of root, and well able to take care of themselves when once established in mixed border or on rockwork. Raising this class of plant from seed is never desirable, unless delay is of no importance and great quantities required. Any nurseryman who makes a speciality of supplying perennials would probably send a rooted plant of *O. tauricum* for about the ordinary price of a micro. slide, which would at once furnish material for several slides, and be a permanent plant for the garden as well, giving annual increase. I frequently adopt this mode of acquisition, and call it "eating my cake and having a bigger."

Among the *Pulmonarias* of this order, *P. Siberica* is a most desirable one to cultivate and examine. The tuberculated appearance (from which, according to the superstition of "Herbs and Signatures," *q.v.*, the lungworts, obtained their generic name) is most strongly marked. W. TEASDALE.

Hairs on Petal of Deutzia.—When hairs and scales are found on the stem and leaves of a plant, it is not at all unusual for them to extend over the calyx and petal of the flower also. Ordinary examples of this may be seen in *Rhododendron ferrugineum* and most of the dwarf species and hybrids. These latter are now very numerous, and their parentage uncertain, as florists give them fancy names unknown to science. Incomparably the most beautiful example I know is the flower of *Correa cardinalis*, when fresh gathered. The calyx shows tawny rosettes on a lovely green ground, the petal pearly stars on a crimson one. Even the footstalk is indescribably beautiful. The plant blooms profusely under glass most of the winter and spring months.

There are five deutzias in cultivation. *D. gracilis* is best known and seen everywhere in its flowering season, early spring. In *D. scabra* the hairs are larger and more developed, and to this it owes its roughness and consequently its scientific name; from the use made of it, probably the hairs are siliceous, a sort of exterior raphides. Both of these are natives of Japan, from which country and from China most of our finest hardy plants of the last thirty or forty years have come. *D. corymbusa* and *D. staminea* are Himalayan species, also white-flowered. *D. sanguinea* is a red-flowered species, of which I have no further information.

W. TEASDALE.

Ramenta of Ferns.—Mr. West's suggestion (see p. 47) that the office of these on the Bracken (?) is the protection of its young

fronds from frost has interested me, and prompts the further suggestion that those so large and numerous on many tropical ferns may possibly, to them, serve as a screen from heat, and tend to check evaporation of moisture from the frond when the air is dry, and possibly also to retain such moisture from dew or otherwise as might from time to time come to refresh the plant.

As to the appearance and development of hairs, scales, etc., upon plants generally, it seems clear that in certain natural orders certain forms are observed to be prevalent on many or most of the plants belonging to them; that in some species they are generally more numerous and conspicuous than upon other species of the same natural order; but when we come to the individual plants themselves, there is in their hairs as much diversity of *development* as there is in the hirsute adornment of the male of that noble animal who subordinates all other created things to his own use and pleasure, his female counterpart forming only occasionally a *rare* exception to prove the rule.

That this animal developes differently under differing atmospheric conditions may be seen by comparing a pretty-faced specimen from a manufacturing town with a ruddy clodhopper reared in the agricultural districts. The difference, however, might not be so evident if the specimens were prepared for examination by being soaked in potash for a week, squeezed flat in a hydraulic press, and fixed in balsam between two slabs of plate-glass. W. TEASDALE.

Fern-Scales.—These occur more or less abundantly on all the British ferns that I have examined. They vary very considerably in general form as well as in shape and size of the cells. They should be looked for, not on the back of the frond (except in Ceterach), but on the *stipe*, the lower portion of which is usually completely covered with them. Many of them polarise well.
W. H. BEEBY.

Plant-Hairs.—Those interested in plant-hairs should get a specimen of our native (?) plant, *Alyssum calycinum*. Almost all parts of the plant are covered with hairs of a very peculiar shape. I give a rough sketch of one of these hairs on Plate III., Fig. 8. Some examples are much simpler than this, while others are very much more irregular. They polarise beautifully. W. H. BEEBY.

Medicago.—Is *Medicago* ever found with quadrifid leaves? I have found four-leaved *Oxalis*, but never four-leaved *Medicago*. The answer to this question might throw some light on which is the true shamrock. W. H. BEEBY.

Acidium compositarium.—These cluster-cups should be viewed

with a Lieberkuhn. It is only when thus seen that the beautiful pavement at the bottom of each well is effectively shown.

A. NICHOLSON.

Parasites to Mount.—I first soak them in glycerine and water, then place them on a slide, add warm jelly, put on cover, and keep the jelly liquid for some time. To show the ramifications of the minute tracheæ, mounting in warm jelly without previous soaking, and allowing them to cool rapidly, answers well.

D. MOORE.

Spiral Fibre in Rhubarb.—This is a favourable opportunity to draw the attention of members to a theory of their formation, which was taught by Dr. Bristowe when I was student, and which he elucidated in a paper in the St. Thomas's Hospital Reports a few years ago. He supposes that the spiral dotted and pitted appearance in cells is produced by the mechanical action of growth acting on a sclerogenous layer (deposited in their interior) when in a viscid state. He illustrates it by reference to the parallelogram of forces. Thus the viscid layer of sclerogen is stretched by the enlargement of the cell-wall in various degrees in two or more directions, the result being a tendency to tear in a direction representing the resultant of such forces.

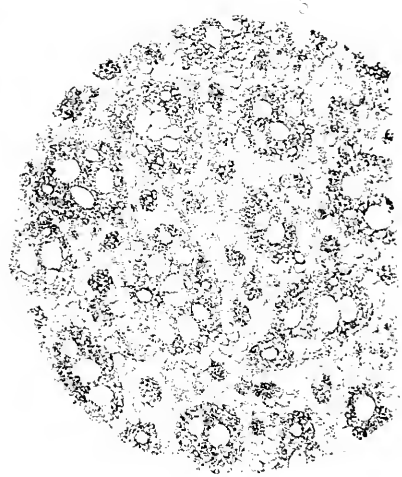
I went into the subject some time ago, and came to the conclusion that the theory was probably right. A good illustration I found in the common garden clematis. In a terminal joint where there is a most rapid growth, and the forces of growth act most evenly, spirals only are found in a second joint. All stages of the tearing process may easily be observed in the newly-formed sclerogenous layer; the original spirals formed when the now second joint was the first, are only stretched open somewhat or increased in size. He thus suggests that they are not deposited as spirals, but as an homogeneous layer of sclerogen, which is made into a spiral or other form by the enlargement and lengthening of the cell-wall by the action of growth, the form being determined by surrounding conditions influencing the amount of stretching force exerted in various directions.

Spiral vessels are common in all quickly-growing portions of plants, and this theory connects together the more rapid growth in such parts with the presence of spiral fibres in certain cells, and is, I think, worth a hearing and further investigations. It is possible that the same theory may account for the formation of the spiral in the tracheæ of insects, but as yet known facts are too few to admit of anything but conjecture.

D. MOORE.

[The above note should have appeared in our January issue, but was pressed out.—*Editor.*]

5



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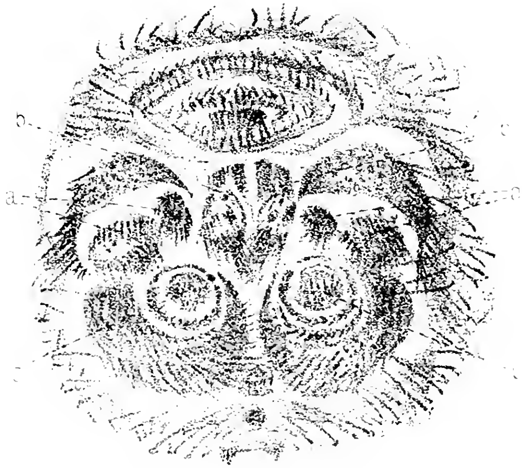
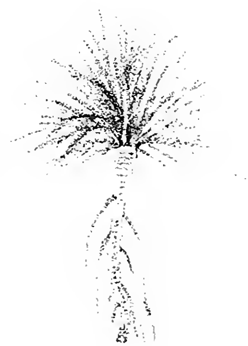




Spiral Vessels to Mount.—Let them be soaked in dilute nitric acid, in which a few grains of nitrate of potash is dissolved, picking out the vessels carefully with a needle, and well wash in water. They may then be mounted at once in glycerine jelly, or further prepared for mounting in balsam. J. CARPENTER.

Testacella.—This mollusc, according to Westwood, is carnivorous, feeding on earth-worms, coming to the surface only at night. Its dentition resembles the *Ianthinæ*. I am inclined to think they are much more common than is supposed, but people do not know where to search for them. H. E. FREEMAN.

EXPLANATION OF PLATE XII.

Fig. 1.—Entrance to the Nest of a Trap-door Spider, *Cteniza Moggridgii*, with the door open. The small dots on the surface of the door represent holes made by the claws of the spider in holding down the door when alarmed.
Drawn by G. H. Bryan.

,, 2.—*Aspidiotus*, × 50, showing *an.*, antennæ; *m.*, mouth; *sp.*, spiracles. Drawn by H. M. J. Underhill.

,, 3.—Section of Screw Pine.

,, 4.—Rough sketch of tree. Drawn by A. Hammond.

,, 5.—Spinnerets of Spider, × 25. It has been attempted to give a general view of the specimen, so far as could be done in so small a figure, without attempting too much detail.
Drawn by Tuffen West.

Correspondence.

[The Editor does not hold himself responsible for the opinions or statements of his correspondents.]

[*To the Editor of "The Journal of Microscopy and Natural Science."*]

SIR,—

The statement of "B.Sc., Plymouth," on p. 56 of your January number, is most misleading.

The root (so-called) of *Beta* is *not* a stem structure at all, as a perusal of any modern text-book of Botany will show clearly. The uppermost portion of it—*i.e.*, the part which tapers *downwards* to the 'shoulder'—corresponds to the *tigellum* of the embryo, this structure often forming a considerable part of the so-called 'root,' as in turnip, radish, cyclamen, etc., etc. All *below* this shoulder is root proper, and bears the well-known distinctive characters of root-structure as opposed to stem-structure.

The root of *Beta* is anomalous in some respects, as are many others, and for a detailed account of its special features I refer your readers to De Bary's "Comparative Anatomy of the Phanerogams and Ferns."

Yours faithfully,

H. W. S. WORSLEY-BENISON.

[*To the Editor of "The Journal of Microscopy and Natural Science."*]

DEAR SIR,—

Kindly allow me space for a suggestion, which, if carried out, would be, I think, of great service to the members of our Postal Microscopical Society. We are even more isolated than many other societies, but not less able and willing to help one another, and a means of easily and quickly obtaining assistance of our fellow-members would add much to the pleasure and success of our work.

To obtain this without restricting or interfering with individual tastes and pursuits, I propose that "circles" should be formed among our members for work either of a general or of a specific character; such as, for example, miscellaneous mounting, photo-micrography, adulteration of food, pond-life, study of algæ, diatoms, desmids, mounting of whole insects, or any other subject taken up as a pleasure for leisure time or for more serious and scientific investigation.

We should require, first, a method of bringing into communication members pursuing the same or kindred branches of microscopical work; secondly, a method of electing a Correspondent and framing some few rules for the greater convenience of all; thirdly, a means of easy and frequent communication between members of each circle and between the different circles when advantageous; and fourthly, a scheme by which the results should be made useful and interesting to all the members of the Society. This could all be done by the following regulations:—

(1) Let members of the Postal Microscopical Society seeking to form or join such "circles" send a letter to our excellent Secretary, giving their names and stating the subjects chosen. Let each enclose six stamps for a "common fund" for the working of each circle, if formed, or to be returned if the circle is not formed. The Secretary would classify the names of applicants, and when sufficient names were sent in to form one or more circles—say, eight members in each—he would enter the names in a "pass-book." This he would send to the member first on the list, who would be "temporary correspondent." The common fund would also be sent to the same.

(2) The "pass-book" should then be sent from member to member in rotation. On its first round each member would enter any suggestions he can offer, his acquirements, facilities, or experience for the work in hand—viz., in mounting, drawing, photography, etc. etc.—and lastly stating whether he be willing or not to undertake the light duties of "correspondent," which will be seen in what follows.

(3) On the second round of the pass-book, each member would vote for the correspondent, writing on one line the name chosen from candidates and his own as voter. The temporary correspondent, on the book reaching him, would add up the votes, giving, if necessary, a casting-vote, and send on the pass-book to the one who receives the majority of votes, with the common fund, and send notice of election to the Secretary of the Society.

We should thus have been brought together for mutual help, and have at hand an easy means of asking, giving, and obtaining help by the continual rounds of the pass-book. If we have eight members in each circle, and if one or two days are allowed for the perusal of the pass-book, the book would come round to each member either every eight or sixteen days. The postage would not exceed one penny. The following might stand as preliminary rules :—

(*a*) Members of the P.M.S. to be exclusively eligible as members of "circle." Application to be made to the Secretary of the Society as in No. 1.

(*b*) Pass-books to be circulated as rapidly as possible in case of voting, and at other times at such periods as may be settled among members of each circle.

(*c*) Postage of "pass-books" and other articles sent round for general use of the "circle" to be paid by each sender.

(*d*) Articles offered by any member for general inspection of circle to be sent in first instance to "Correspondent."

(*e*) Each member to enter in "pass-book," diligently and concisely, queries, answers, and results of work.

(*f*) Correspondent to "summarise," each quarter, notes from "pass-book" for publication in Journal of the Society—say, under a heading, "News from the Circles."

(*g*) Boxes of slides to be formed as often as possible from the work of members, and to be sent by "Correspondent" to our Secretary for circulation through the Society. (The box should first go the round of the circle sending it out for notes of general interest.)

(*h*) The "common fund" would be used by Correspondent for expenses incurred in postage, etc. A small levy now and then would, perhaps, be necessary.

(*i*) Unanswered queries, etc., might be sent by "Correspondent" to other circles or to the *Scientific Enquirer.*

(*k*) List of circles, with name and address of "Correspondent," at least, to appear in the Journal of our Society.

Thus, I think, we should work in better harmony, more pleasantly and more usefully. In many cases of special difficulty we should know where to seek information and to obtain it *quickly* and *cheaply* from members of our own circle, or, if necessary, from other circles.

Our very excellent Secretary, Mr. Allen, is, as usual with him, quite ready to undertake the extra duties involved by this scheme. If members will as soon as possible send in their names as I propose in No. 1, we could at once begin, and experience would soon help us to form some good and permanent rules for the better working of the circles.

A MEMBER.

Reviews.

A MANUAL OF BRITISH DISCOMYCETES, with a Description of all the Species of Fungi hitherto found in Britain, included in the family and illustrations of the Genera. By William Phillips, F.L.S. Crown 8vo, pp. xii.—462. (London: Kegan Paul, Trench, and Co. 1888.)

This volume is the sixty-first of the International Scientific Series, and is designed to provide the English student with the means of acquiring a knowledge of the Discomycetes of Britain. The author evidently has spared no pains in verifying and extending observations of the morphology, for in no instance where an authentic specimen was accessible has the opportunity of examining it been neglected. The author divides the Discomycetes into the following orders:—

1.—Helvellaceæ,	containing	10	genera.
2.—Pezizæ,	,,	12	,,
3.—Ascoboleæ,	,,	6	,,
4.—Bulgarieæ	,,	5	,,
5.—Dermateæ,	,,	6	,,
6.—Patellariaceæ	,,	3	,,
7.—Sticteæ,	,,	3	,,
8.—Phacidiaceæ,	,,	3	,,
9.—Gymnoasceæ,	,,	1	genus.

At the end of the book are added an Addenda of certain species which have been omitted from the body of the work, a Glossary of Terms, Description of Plates, and General Index. We must not omit to mention that there are twelve excellent plates.

DIE NATURLICHEN PFLANZENFAMILIEN nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutzpflanzen bearbeitet unter Mitwirkung zahlreicher hervorragender Fachgelehrten von. A. Engler und K. Prantl. Nos. 13, 14, 15.

Since our last notice we have received three parts of this fine work, con-

taining contributions from Messrs. A. Engler, H. Graf zu Solms, E. Hackel, F. Pax, and K. Prantl. The illustrations number 97, consisting of upwards of 500 figures. The subscription price to this work is about 1s. 6d. each part; price to non-subscribers, 3s.

A MANUAL OF NORTH-AMERICAN BIRDS. By Robert Ridgeway. Royal 8vo, pp. xi.—631, plates 124. (Philadelphia: J. B. Lippincott and Co. 1887.)

This fine work was originally projected by the late Professor Spencer F. Baird, and is based essentially upon the grand National Cabinet of American Birds, which his energy, ability, and enthusiasm have developed from an unpretentious nucleus to an unrivalled collection. It is intended to furnish a convenient manual of North-American ornithology, reduced to the smallest compass by the omission of everything that is not absolutely necessary for determining the character of any given specimen, and including besides the correct nomenclature of each species, a statement of its natural habitat, and other concomitant data.

The 124 plates contain 464 finely-executed outline drawings of the generic characters. A fine portrait of Prof. Baird forms a frontispiece to the volume.

GUIDE PRATIQUE pour les Travaux de Micrographie, comprenant la Technique et les Applicationes du Microscope a l'Histologie Végétale et Animale, a la Bactériologie, a la Clinique, a l'Hygiène. et a la Médicine Légale. Par MM. Docteurs H. Beauregard et V. Galippe. Crown 8vo, pp. vii.—901. (Paris: G. Masson, 120 Boulevard Saint Germain. 1888.)

The authors of this treatise have set before themselves a difficult task—to produce a book that shall be a miniature library of all subjects connected with microscopy; and though, perhaps, it would be hardly correct to say that they have achieved perfect success, yet they have produced a work of great value to the student. The first few pages are devoted to the optical and mechanical arrangements and to the preparation of microscopic objects. The main portion of the work consists of, we might almost say, exhaustive treatises on Vegetable and Animal Histology. We have a very instructive series of sub-chapters on the Cell, its contents and changes. Then there is another series that deals with the interesting question of Bacteria, pointing out the practical way of studying this, in the present day, burning question. In the same way, when we come to Animal Tissues, we have excellent treatises on Milk—its derivatives and their adulteration, Blood-Parasites, Hairs, etc. There is also a valuable chapter on the organisms that are found floating in the air. The work is fully illustrated with wood engravings, which, judging from those that come within the range of our own knowledge, we can pronounce to be true to nature and very effective.

PRACTICAL MICROSCOPY: A Course of Normal Histology for Students and Practitioners of Medicine. By Maurice N. Miller, M.D. Royal 8vo, pp. xv.—217. (New York: William Wood and Co. 1887.)

This will be found a most useful work. It is divided into three parts:—1.—Technology, in which the Microscope and Accessories are fully described, with the method of preparing, cutting, staining, etc., tissues for microscopical purposes; 2.—Structural Elements; and 3.—Organs, followed by Microscopical Formulæ. The illustrations—of which there are 126—are photographical reproductions of the author's own drawings and are very good.

FOSSIL MEN and their Modern Representatives: An Attempt to Illustrate the Characters and Condition of Pre-Historic Men in Europe by

those of the American Races. By J. W. Dawson, C.M.G., LL.D., F.R.S., F.G.S., etc. Crown 8vo, pp. viii.—354. (London: Hodder and Stoughton. 1888.)

This work is intended as a popular exposition of some of those important topics in which geologists, archæologists, historians, philologists, and anthropologists are not always agreed. These the author treats from the point of view of the geologist and naturalist, and on the principle of referring to modern causes for the explanation of ancient effects. It contains 46 good engravings.

A Popular Zoology. By J. Dorman Steele, Ph.D., and J. W. P. Jenks, A.M. 8vo, pp. xiii.—319. (New York and Chicago: A. S. Barnes and Co. 1887.)

This work will prove a valuable one to the young student. Its principal features are brevity, directness of statement, frequent foot-notes with anecdotes, and a gradual introduction of scientific terms and language, so as to fit the scholar to read zoological literature. It abounds with woodcuts, there being no fewer than 481, each animal being figured. The text is largely occupied with biography, telling us "how animals act, think, and are mutually related." Every class of the animal kingdom is named, with most of its orders and many of the principal genera. We note, too, that every scientific word is carefully *pronounced*. In the appendix will be found directions for collecting and preserving specimens. At the end of the book a most useful table is given of the systematic arrangement of the representative forms mentioned in the book. It is a book with which we are much pleased.

Tenants of an Old Farm: Leaves from the Note-Book of a Naturalist. By Henry M. C. McCook, D.D. With an Introduction by Sir John Lubbock, M.P., F.R.S., etc. Crown 8vo, pp. 460. (London: Hodder and Stoughton. 1888.)

This admirable work has, we believe, already found a very large sale in America. In it the author gives, in a most pleasant, colloquial style, a number of essays on his own peculiar specialities, more particularly ants and spiders, although he tells us that, "like most naturalists, he thinks that the truths of nature are attractive enough in themselves, and need not the seasoning of fiction, even of so mild a flavour as offered by the "Tenants." He assures us that most of the facts came under his own observation. By introducing the "tenants," more especially "Old Dan" and "Sary Ann," he is able to add much folk-lore concerning insects, which perhaps would otherwise either have been left out altogether, or certainly not told in so pleasant a manner as we now have it.

We strongly advise our friends to get a copy of this book. It is a great favourite with us. The illustrations are remarkably good.

Insect Ways on Summer Days in Garden, Forest, Field, and Stream. By Jennett Humphreys. Crown 8vo, pp. 192. (London: Blackie and Son. 1888.) Price 2s. 6d.

A series of instructive facts, very interestingly told, about many tiny things by which we are surrounded. Each insect described is nicely illustrated by an engraving. We cannot, however, help thinking that the fair authoress has made one slight mistake when she says that the Water Boatman (*Notonecta glauca*) feeds upon the Watermite and the *Crab-Louse* (! !), both of which are represented in the illustrations.

A Student's Manual of Psychology, adapted from the *Katechismus der Psychologie* of Friedrich Kirchner. By E. D. Drought,

Crown 8vo, pp. viii.—344. (London: Swan Sonnenschien and Co. 1888.) Price 4s. 6d.

The aim of the author of the work before us has been to make the reader thoroughly acquainted, both with the present state of psychological investigation and with the difficulties of the individual problems. It presents psychology to educated persons—more particularly to students, examiners, and teachers—in a popular though by no means superficial manner. The introductory portion of this manual is divided into four sections, and treats of—1, The Meaning of Psychology; 2, Its relation to other Sciences; 3, History of Psychology; 4, Method of Psychology; 5, Division of the subject. The body of the work is divided into two parts:—Part I. treats of the Nature of the Soul; Part II., The Mental Faculties.

DISCURSIVE ESSAYS on the Phenomena of the Heavens and Physical History of the Earth. In two parts. Part I. By "Cosmopolitan." 8vo, pp. xxxii.—330. (London: Literary Society, 376 Strand.) Price 6s.

This volume contains A New Theory in Astronomy, based on the Translatory Motion of the Sun, and a New Theory on the Element of Cold in the Universe, followed by a description of the Probable Origin of the Earth, Formation of its Ocean, Crust, Continents, and Islands, including a concise review of the Evolution of the Organic Beings on its Surface.

CHEMICAL LECTURE NOTES. Taken from Prof. C. O. Curtman's Lectures at the St. Louis College of Pharmacy. By H. M. Whelpley, Ph.G. Crown 8vo., pp. 143. (St. Louis, Mo., U.S.A.: The Author.)

The student in chemistry will find these notes helpful. They were originally published in the *National Druggist*, and treat of Chemical Physics, the Chemistry of Metalloids, the Chemistry of Metals, and Organic Compounds.

THE MEDICAL ANNUAL and Practitioner's Index. Crown 8vo, pp. 568. (Bristol: J. Wright and Co. London: Hamilton, Adams, and Co. 1888.) Price 5s. 6d.

It is with much pleasure that we welcome to our editorial table this useful work, and shall soon begin to regard it as an old friend. Since its commencement we have noticed a continued yearly improvement, and congratulate the editors on so successful a termination of another year of their labours. The busy practitioner will, in many instances, find here the information he requires put in very practical terms.

A summary of the year's work in Medicine, Surgery, and Therapeutics has been placed before the reader. The arrangement is alphabetical, and the directions are in clear and concise language. We have also a list of the principal medical works published during the past year—Notes on New Inventions, Improvements in Pharmacy, etc., Lists of Private Asylums and Homes for Inebriates, and of Hydropathic Establishments in Great Britain—and at the end of the book are blank pages for notes. We cordially recommend it.

THE DICTIONARY OF NEW TREATMENT. Edited by Percy Wilde, M.D. (Medicine and Therapeutics), and W. H. Elam, F.R.C.S. (Surgery). Crown 8vo, pp. 432. (Bristol: John Wright and Co. London: Hamilton, Adams, and Co.)

"The Annual" for 1887 being out of print, it was decided to reprint this portion of the work in a separate form. It contains a concise description of the New Methods of Treatment, both medical and surgical, which have been introduced during recent years, and may be considered as an appendix to the

systematic treatises on Medicine and Surgery. The Therapeutics of the New Remedies are fully considered under the names of the diseases for which they are especially employed. At the end of the book will be found an exhaustive Index of Remedies and another of Diseases. Whilst this volume and "The Medical Annual" for the current year are complete in themselves, each will be found to be complemented by the other.

THE PHILOSOPHY OF WORDS: A Popular Introduction to the Science of Language. By Frederico Garlanda, Ph.D. Crown 8vo, pp. 294.

THE FORTUNES OF WORDS: Letters to a Lady. By Frederico Garlanda, Ph.D. Crown 8vo, pp. 225.

(London: Trubner and Co. 1888.)

In the two little books before us the aim of the author is to explain as plainly as possible some of the most important results of the science of language, whence our words come, what is their true meaning, and how is our language connected with those of people around us. He thinks many people speak too much as birds sing, without ever bringing our minds to reflect on the nature of the sounds we utter.

THE PHILOSOPHY OF WORDS treats of Sounds and Language, the English Language divided into Household Words, Church Words, Words of Society, and Political Words; Comparative Grammar; Language and Rules; Local and Family Names, etc. etc.

THE FORTUNES OF WORDS, which is written in the form of a series of letters to a lady, treats very fully of the roots from which our words are derived. Both books will well repay very careful study.

DURRANT'S HAND-BOOK FOR ESSEX. By Miller Christy. Crown 8vo, pp. viii.—237. (Chelmsford: Edmund Durrant & Co. London: Simpkin, Marshall, and Co. 1887.) Price 2s. 6d.

This useful hand-book offers for the use of tourists and others a guide to the principal buildings, places, and objects of interest in each parish of the county. We have also a nice account of the History, Geology, Area, Population, Literature, Antiquities, Worthies, and Natural History. It contains also a map and two plans.

THE TRADE-SIGNS OF ESSEX: A Popular Account of the Origin and Meanings of the Public-House and other Signs now or formerly found in the County of Essex. By Miller Christy. 8vo, pp. xii.—184. (Chelmsford: E. Durrant and Co. London: Griffith, Farran, and Co. 1887.) Price 7s. 6d.

Being for many years resident in Essex, it is with much interest that we turn our attention to this and the preceding interesting books. The signs of Essex are classified under the titles Heraldic, Mammalian, Ornithological, Piscatorial, Insect, Reptilian, Botanical, Human, Nautical, and Miscellaneous. Mr. Christy has performed his task in a thorough and masterly manner, and gives his readers a large amount of valuable information on what at first sight appears a somewhat unimportant subject. At the end is a Glossary of the Heraldic Terms used in the book. The work is well illustrated, the frontispiece to the volume being a curious old engraving of Chelmsford High Street in 1762.

OBSERVATIONS ON POPULAR ANTIQUITIES, chiefly illustrating the Origin of our Vulgar Customs, Ceremonies, and Superstitions. By John Brand, with the additions of Sir Henry Ellis. Crown 8vo, pp. xvi.—807. (London: Chatto and Windus. 1888.) Price 7s. 6d.

Much light is thrown on many of our old-fashioned customs, such as eating Pancakes on Shrove Tuesday, Cross-Buns on Good Friday, the Michaelmas Goose, Mince-Pies at Christmas, etc., and on the forms and ceremonies customary on many of the Saints' Days; Marriage Customs and Ceremonies, Customs at Deaths, Sports and Games, Omens, Charms, Divinations, and very many other things too numerous to mention. The book is not only well worth reading, but should be kept as a book of reference with respect to those old wives' sayings that we so often meet with. It is capitally illustrated.

Exercises in Arithmetic. By the Rev. T. Dalton, M.A., Assistant Master at Eton College. Crown 8vo, pp. 152. (London: John Murray. 1888.)

This is one of the Eton Mathematical Series, and is designed to provide exercises for work out of school. It is published without answers, but the answers may be obtained from the publishers on the *bonâ-fide* application of any schoolmaster or teacher. Pages 1 to 130 each contain ten questions of a miscellaneous character; pages 131 to 140 are of a selected nature; the rest are selected questions from Cambridge, Oxford, and other examination papers.

The Diseases of the Bible. By Sir Risdon Bennett, M.D., LL.D., F.R.S. Crown 8vo, pp. 144. (London: Religious Tract Society. 1887.) Price 2s. 6d.

We are glad to find that learned men of the present day are doing much to elucidate certain portions of Holy Writ, and to show that there is no real antagonism between Biblical records and 19th century science. The region into which the talented author conducts us is one to which the ordinary reader is seldom admitted. The work before us is divided into seven chapters, and treats of Leprosy; Plague and Epidemic Diseases; Ophthalmic Diseases and Blindness; Diseases of the Nervous System; Diseases of Job, Herod, Hezekiah, Jeroboam, and the Shunamite's Wife's Son; Old Age; and the Physical Cause of the Death of Christ. In the Appendix Fiery Serpents are spoken of.

The Evangelisation of the World. Crown 8vo, pp. 242. (London: Morgan and Scott.)

Shows what good work may be done by an earnest band of Christian workers. The photographs and other illustrations (many of them being from photographs) are exceedingly well executed. The book is full of interest.

Gospel Ethnology. By S. R. Pattison. Post 8vo, pp. viii.—226. (London: The Religious Tract Society.) Price 5s.

This little book, which contains upwards of thirty typical representations of the human race, from as many different portions of the world, treats of the Physical Unity of Man and the Spiritual Unity of Man; then of the three types of Black Races of Men accepting the Bible; fifteen types of Yellow Races; and fourteen types of Brown and White Races. The illustrations, many of them full page, are very good.

The Gospel in Nature: Scripture Truths illustrated by Facts from Nature. By Henry C. McCook, D.D., with an Introduction by W. Carruthers, President of the Linnæan Society, F.R.S., etc. Crown 8vo, pp. xii.—416. (London: Hodder and Stoughton. 1888.)

A very fresh volume of discourses, thoroughly evangelical in tone, in which carefully-ascertained facts, gathered from a wide field of nature, are used as illustrations of spiritual truths. The standpoint of the writer is

"Nature is God's great book of parables." Some of the lessons appear to us far-fetched, but they are always such as do not depend for their force on the strictness of the assumed analogy. Dr. McCook is not only a diligent and successful student of Nature, but is also one of the leaders of theological thought in America.

SCRIPTURE NATURAL HISTORY. I.—Plants and Trees mentioned in the Bible. By William H. Groser, B.Sc. (Lond.). Crown 8vo, pp. viii.—235. (London: The Religious Tract Society. 1888.) Price 3s.

This interesting work opens with a Sketch of the Vegetation of Palestine and the Neighbouring Countries; followed by an account of the Timber and Forest Trees and Shrubs; Fruit-Trees and Shrubs; Grain and Vegetables; Herbs and Flowers; Perfumes and Medicines; and the Emblematic Use of Plants in Scripture. It is illustrated with 14 well-executed plates.

AUSTRALIAN BALLADS AND RHYMES: Poems inspired by Life and Scenery in Australia and New Zealand. Selected and edited by Douglas B. W. Sladen, B.A. Square 16mo, pp. xxiv.—301. (London: Walter Scott. 1888.)

A very nicely got-up volume of the "Canterbury Poets." Each volume is neatly bound in cloth gilt, with red edges, and the pages throughout have a red-line border. It is with pleasure that we notice this interesting little volume, and congratulate editor and publisher on their success.

THE LETTERS OF ROBERT BURNS, selected and arranged, with an Introduction by J. Logie Robertson, M.A. (London: Walter Scott. 1887.)

A volume of the monthly "Camelot series," which, like the volume just noticed, is also published at 1s.

LIFE OF OLIVER GOLDSMITH. By Austin Dobson. (London: Walter Scott. 1888.)

This is one of the monthly shilling volumes of the "Great Writers'" series, and is edited by Professor E. S. Robertson. It is very neatly bound in cloth, contains a capital index, and an exhaustive bibliography of Goldsmith's works by John P. Anderson, of the British Museum.

THE DAWN OF THE TWENTIETH CENTURY, 1st of January, 1901. Crown 8vo., pp. 156. (London: Field and Tuer. 1888.)

This little *brochure* opens with an extract from "The Constitution" of the 1st of January, 1901. We find Edward VII. on the throne, the Queen having recently resigned. The love of her peoples—which never wavered during a reign happily so lengthened—follows her Majesty as fervent and profound as ever into the comparative retirement of Osborne and Balmoral. Then follows the reports of the various secretaries, etc.

A TREATISE ON PHOTOGRAPHY. By Capt. W. de Wiveleslie Abney, R.E., F.R.S. Fifth edition, revised and enlarged. Crown 8vo, pp. xvi.—368. (London: Longmans, Green, and Co. 1888.) Price 3s. 6d.

The name of the author of this treatise is a sufficient guarantee that it, like all the rest of the series ("Text-Books of Science"), contains a large amount of valuable information. The edition has been, in a great measure, re-written in certain portions, and a considerable quantity of new matter added. The author's aim has been to give a rational explanation of most of the different phenomena to be met with in Photography, and at the same time to give sufficient practical directions to enable the student to produce a picture which should be technically good, and also to show how photography may be made an aid to research.

WILSON'S PHOTOGRAPHICS: A Series of Lessons, accompanied by Notes, on all Processes which are needful in the Art of Photography. Fcap. 4to, pp. 336. (New York: E. L. Wilson.)

Dr. Wilson is undoubtedly a master of the art he undertakes to teach in the handsome book before us. He tells us that in writing it "I agreed in the beginning that I would tell what I knew from experience in simple language—this for the benefit and instruction of the beginner—at the heads of the pages, in bold and honest type, and then, in the smaller and less dignified letter following, elaborate, with the extended ideas of those who have accelerated the advancement of our art by their discoveries, their practice, and the publication of their experience." This volume is very handsomely got up on fine paper and illustrated with five phototypes, one being the portrait of the author, and 110 photo engravings and woodcuts.

PHOTO-ENGRAVING and Photo-Lithography in Line and in Half-Tone; also Collotype and Heliotype. By W. T. Wilkinson. Second edition, revised and enlarged. Crown 8vo, pp. 200. (London: England Bros., Charles St., Notting Hill. 1887.)

In the work before us the whole art of Photo-Lithography and of Photo-Engraving is very thoroughly described. The method also of making relief blocks from drawings, transferred to zinc without the intervention of photography, and also the two processes of Collotype and Heliotype, have been added. The author assures us that no formula or method has been given that has not been tried. We may, therefore, look upon the book as being very practical. We think it will prove very useful to those who wish to have their books nicely illustrated, and more particularly so to those who wish to practice the art.

THE AMERICAN ANNUAL OF PHOTOGRAPHY and Photographic Times Annual for 1888. Edited by C. W. Caufield. 8vo, pp. 327. (New York: Scovelle Manufacturing Co. 1888.)

The articles in this very useful annual have all been written expressly for the work itself, and contain a vast amount of valuable information. The illustrations—which consist of a Landscape by Obermetter's Photogravure Process, an Eastman's Bromide Paper Print, a Zinc Etching by Stevens' Process, a Portrait by the Ives Process, Landscape Photo-Lithograph, and three Moss Type—are all excellent specimens of art. There are also several wood engravings.

ELECTRICAL-INSTRUMENT MAKING FOR AMATEURS. By S. R. Bottom. Crown 8vo, pp. viii.—175. (London: Whittaker and Co., Paternoster Square. 1888.)

The author, having felt the want, commonly experienced by most amateurs, of a helping hand, gives in the nice little book before us such help as he believes will assist the tyro in his attempts at the construction of the more useful pieces of electrical apparatus, and shows how much trouble may be saved and expense spared by the adoption of certain simple modes of procedure. He makes no attempt at the expensive "brass and glass" work, as seen in the opticians' windows, but promises that his instruments may be relied on to act efficiently, which undoubtedly is the more desirable end to be aimed at. The work is illustrated with about sixty very clear engravings. It is certainly a very useful book.

THE JOURNAL OF INDIAN ART. Nos. 1 to 21. Large folio (about 15 inches by 11 inches). (London: W. Griggs, Hanover St., Peckham; Quarritch, Piccadilly.) Price 2s. each part.

These parts will form one of the most handsome books with which we

have for a long time been favoured. The most attractive feature of the work is its very handsome and numerous plates, which are all executed in photo-lithography by W. Griggs, of Peckham. Many of the plates are printed in a number of colours. It would be impossible to describe the contents of each number. We will take No. 12, which was published in June, 1887. It contains a portrait of her Majesty the Queen-Empress; H.H. the Maharaja of Jeypore; H.H. the Maharaja of Ulwur; Plan of the Indian Courts of the Colonial and Indian Exhibition; the Jeypore Pavilion and Screen; Details of Screens; and many others. The letterpress accompanying each part is descriptive of the Arts and Industries of India.

NATURAL PHILOSOPHY FOR BEGINNERS: Mechanics, Hydrostatics, and Pneumatics. By William Nicolls, B.A. Third edition; pp. 122. (Dublin: E. Ponsonby. 1887.) Price 2s.

We are glad to see that this useful little work has reached its third edition. Although written in the first place for intermediate schools, it will be found of much value for all students who are desirous of mastering the elementary laws of matter and motion. The first part treats of the fundamental properties of solids, liquids, and gases, including an account of the metric system of weights and measures, and descriptions of the various mechanical powers. The second part forms a first step to the study of statics, pinetics, and hydrostatics, Newton's laws of motion being, of course, taken as the fundamental basis on which the dynamical properties of matter depend. The introduction of the conception of Veetors in treating pinematical propositions is much to be commended, as giving the student an early notion of modern dynamical views. Each chapter is illustrated by numerous examples and well-selected questions, a set of miscellaneous examples being appended at the end of the work. It is surprising what a large amount of information Mr. Nicolls has condensed into this little book. Moreover, this has not been done at the expense of clearness, for the explanations are remarkably lucid and easy of comprehension.

THE DIVIDED IRISH. By the Hon. Albert S. G. Canning, author of "Revolting Ireland, 1798 and 1803," "Thoughts on Shakespere's Historical Plays," etc. Crown 8vo, pp. 86. (Newry, Ireland: J. Warnock and Co. 1888.) Price 1s.

In the little book before us Mr. Canning has collected his facts from a great variety of sources, and assures us that he has endeavoured to treat modern Irish history with thorough impartiality. It will donbtless be read with much interest at the present time.

LA PHOTOGRAPHIE MODERNE: Pratique et Applications. Par Albert Londe. Royal 8vo, pp. 312. (Paris: G. Masson, editeur, Libraire de l'Academie de Médecine, 120 Boulevard St. Germain. 1888.)

Of the many useful treatises on photography that have come before us, we think that we may fairly award to the present work the position of the first. Not only is it a handsome volume, well printed, and well illustrated, but it carries down the practice of the photographic art to its latest developments, its application to astronomy, or, rather the charting of the stars and the reproduction of the lunar features, which are well illustrated and explained; instantaneous photography, as a means of investigating the flight of birds and the actual movement of animals; the use of the camera in the field, both for peaceful and warlike purposes, are well brought out. We have no hesitation in recommending this work to our readers as one of the best, if not the best, of its kind.

The Romance of Seed-Sowing.

By H. W. S. Worsley-Benison, F.L.S.

EVERY country child knows the appearance of a 'Dandelion-clock,' and has tried to "see what o'clock it is" by the number of puffs needed to blow away the round head of soft down at the top of the flower-stalk in Autumn. Equally familiar is the smaller tuft of grey down on Groundsel after flowering, although most people do not know that the botanical name of Groundsel is *Senecio*, from the Latin *senex*, 'an old man,' given to it on account of the colour of this down. Most of us can recollect the innumerable tufts of similar material flying all over a thistle-field long after Butterfly and Bee have done their work among the purple flowers. We have all seen Sycamore 'keys' strewing the ground in June and July, and brown Ash 'keys' persistent on the parent tree when October winds have blown nearly every leaf from its hold. The bonnie Autumn berries in our woods, and the fruits of Blackberry and Strawberry have been gathered by children of younger and older growth many a time and oft.

How many of us ever stay to inquire *why* Groundsel and Thistle possess their downy tufts, *why* Ash and Sycamore produce their 'keys,' or *why* many of the trees and plants are dressed in fruiting time with crimson and scarlet, purple and olive? Not only in order to the uses *we* make of them, we may be quite sure. 'Dandelion-globes' and 'Thistledown blows' do not exist *only* to tell the time of day to a four-year-old child, or "he loves me—he loves me not" to the maiden of seventeen. Ash and Sycamore have 'keys' for some other purpose than to form graceful, drooping clusters in June. The fruits and berries are not solely for decoration and digestion by human gatherers.

Were these their only reasons for existence, that would soon terminate, in all probability. All these and many others that we could name gladden and delight us in various ways, as do the

flowers that come before each one of them; but, as with the flowers, so with down-tuft and 'key,' berry and fruit; they all have their several missions to perform, in order to perpetuate the very existence of their species, and to hold their own in the battle of life.

Acknowledging that while they last, they are, in a thousand forms and ways, beautiful and useful, I wish to try to show the definite uses of these "common things," and of some curious and wonderful contrivances to be found in plant-life all around us. To come to the subject-matter of this lengthy introduction, let us look for awhile at the various methods by which, either through external agency or intrinsic power, trees and plants manage to disperse their seeds, and to secure for their offspring a suitable home, and a fit and proper environment.

The first question that naturally arises in many minds will probably be, Why try to scatter or disperse them at all? Why not let them take their chance, and simply fall to the ground immediately underneath the tree, shrub, or annual, as the case may be, there to germinate and grow up into their parents' likeness?

This is quite easily answered. In the case of trees, if all the seeds fell round about the trunk, they would stand a poor chance; for if they ever germinated at all, the young seedlings would get very little sun, and a great deal too much over-shadow, and would be further harmed by the 'drip, drip,' from the branches. In the cases of both trees and plants, moreover, the large quantity of young plants would choke one another in the struggle for life; indeed, this not seldom occurs with some of our garden annuals, as we can easily prove for ourselves. Again, many plants soon exhaust the earth of certain mineral materials, and if their seedlings attempted to grow in the same soil, they would fail, the parent plant having used up the chief portion of such substances.

A parallel to this is found in the fact that farmers do not grow the same kind of plant for successive seasons in the same field, but vary the sort from year to year, choosing plants that draw different materials from the soil in consecutive years. 'Rotation of crops' we call it, but it is not our own

invention. We took centuries to find it out. The plants and trees knew of it long ages ago, and so were led to develope the various methods of ensuring a speedy and effectual transit of their seeds to other and better soil, where they might find their needed foods in rich abundance. Of course, in certain cases—notably of some very small annuals, whose roots practically exhaust the soil but little—their seedlings find a good position at once, and manage to flourish; those growing on sloping grassy downs or cliffs, too, stand a better chance, inasmuch as their seeds fall on ground at a lower level than that drawn on by the parent plant. Examples of this are seen in our wild Snap-drapons, Wall-flowers, and others, growing in such profusion on railway-banks or on sloping limestone cliffs. For the most part, however, those plants flourish best that develope tendencies that tell in the direction of effectual dispersion of their seeds.

I must not omit mention of one thing, before detailing the methods of dispersion. Seeds must not be scattered until they are 'ripe,' and ready to set up their own independent existence. Hence, we find all sorts of devices for *protection* of seeds during their growth.

Some are enclosed in a thick, hard shell, such as Hazel-nut, Beech-nut, Spanish Chestnut, Cocoa-nut, Monkey-pot, and many others. Some are hidden away under overlapping wooden scales, such as the cones of Firs and their allies. Some are surrounded by thick fleshy coats, such as Horse-chestnut, Almond, Apple, Cherry, and the like.

Walnut has a covering which is not only tough, but bitter to the taste. *Mucuna*, one of the *Leguminosæ*, has its pod covered with stinging-hairs.

Some have the calyx closed over the ripening seeds, as Winter Cherry, Strawberry-headed Trefoil, Herb Robert, and some others of the same order. The wild Rose-fruits nestle inside the hollowed-out flower-stalk which forms the Hip, whose scarlet colour stands out in beautiful relief on the bushes in September and October. Many Clovers have the withered corolla for a covering to their seed-containing pod, and perhaps no plant better knows how to protect its progeny than Gorse, whose hair-covered pods defy wind, storm, and insect, until

the seeds are fully ripe, and ready to be scattered by the bursting of the pods in the August sunshine.

Finally, there are some plants which by movement ensure protection. The little *Linaria* of our rockeries and walls—'Mother-of-Thousands,' as West-country folk call it, revels in sunshine, but as soon as it is fertilized, it pushes itself into some cranny or nook, hiding its seeds away until they are ripe. Dandelion keeps its stalk bolt upright during the three or four days of flower-expansion, but it bends down close to the earth, and buries its flowers among the grass for ten or twelve days while the seeds are getting ripe, afterwards becoming erect once more, for a reason which we shall presently consider.

Now, let us see what are the agencies by which seeds are sent or carried on their journeys. There are four chief ones, besides one or two minor methods seen in only a few instances. We will take the four principal ones first of all.

I.—Water.—Under this head I include the action of rivers and ocean-currents.

Comparatively few seeds are carried by water, owing to their being, as a rule, unable to withstand prolonged immersion; but it is still true, that the agency of water is a very important one, especially in the form of marine currents. Many seeds are small and light enough to need no further adaptation; but in the case of the larger kinds, they must not only be able to answer to the law governing floating bodies, too well known to quote here, but they must also be absolutely impermeable to water itself. The Cocoa-nut rind is woody and fibrous. Hence these fruits can easily withstand the action of sea-water and protect the seed within. They may be carried for thousands of miles over the sea, and yet when stranded, the seeds can readily germinate. In this way we account for the wide range of this Palm and its presence on the main coral islands of the Pacific. Many seeds and fruits have thus been carried by the great current of the Gulf Stream from Mexico, to the marshes on Ireland's western coast, to the lakes of the Hebrides, and to the Norway coast. Others have gone by currents from Madeira to the Canaries, and thence to the African borders.

Rivers, again, act in a similar manner. Seeds and fruits are

brought down from the mountainous districts, and deposited among the level plains and grassy meadows, and thus we can easily account for the presence of such species in what seem to us strange habitats for them. Both in marine currents and in rivers, the action of water in carrying seeds *to any purpose* is most effectual when the direction is from W. to E., or the opposite, because then, the seeds are kept pretty much within the same latitude and therefore in similar climates. Hence they will grow and flourish where they eventually settle as well as they did in their former home. Currents going from N. to S. or S. to N. take them into unfavourable surroundings, and then they mostly perish.

Some seeds are specially fitted for water transit by the presence of air-bladders variously developed—*e.g.*, those of Water-lily. Others have a smooth rind with an oily juice, such as those of Arrow-head (*Sagittaria*), of our water-ditches. This peculiarity is, of course, of advantage in swampy and marshy districts, where the water dries up in warm weather, and the courses of the current vary so much.

II.—Winds.—In many ways we see the action of this second agent. The simplest cases are those where the seeds (or their equivalents) are infinitesimally small, and of exceeding lightness. Thus, the *spores* of *Fungi*, Lichens, Mosses, and Ferns are easily carried by the wind to distant places; and so the members of some of the above-named Orders have an almost world-wide range.

Some seeds of Flowering plants are also light enough to be thus transported, or else they have some mechanical contrivance to render them so. One of our little Corn-salads (*Valerianella auricula*), whose fruit contains three cells, developes only one seed, the remaining two empty cells acting as a kind of balloon to the fruit, and most likely facilitating their movement by the wind. Then, again, there are seeds which are flat and very thin. Those of Yellow-rattle, a parasite on meadow-grasses, afford an example. The wind shakes them out of their bladder-like capsule at ripening-time, and carries them to a distance, where they find a congenial resting-place.

Coming to more familiar and more easily-seen contrivances, we find the *winged* fruits and seeds, known to most of us.

Among winged *fruits* we have the keys, or doubly-winged fruits of Sycamore and Maple, the single one of Ash, and the well-known winged nuts (so called) of Birch and Elm, those of the latter covering the roads in April and early May. When the winged fruit is detached from the tree, it falls slowly with a rotatory motion, and the wind, if enough be present, is sure to catch it and bear it away. Lime has no winged fruit, but the long, narrow bract at the base of the bunch of fruits serves the purpose. Watch a bunch of Lime-fruit falling, and note that the fruits hang lowermost, the bract catching the wind and carrying the whole mass away—very often to some distance. Among plants also, we find instances of winged fruits, as in Dock, Parsnip, and Penny Cress, the latter being, like others of its Order, a winged pod, or pouch, containing the seeds.

In the case of Pine, it is the *seed* which is winged—*i.e.*, it carries with it a portion of the scale to which it was formerly attached. So, if you examine the tiny seeds of *Arbor vitæ* and Cypress in our gardens, you will find these to be surrounded by a thin membranous wing; equally provided are those of the beautiful Trumpet-creeper, while the seeds of some Bignonias are so delicately winged that you can watch them describing a series of circles in the air, hovering, so to speak, before they finally settle.

There is one instance of a wind-wafted fruit which, although not winged, I may name here. I refer to the 'Rose of Jericho,' a pod-bearing annual found in Syria and Egypt. Its pods, when dry, curl themselves up into a ball, and are driven, it may be, for miles along the ground by the wind, until they happen on a damp place; there they stick, uncurl, open, and deposit their seeds. There is another case: a kind of Grass, in which the whole inflorescence, in the shape of a large round head, gets driven along the sands of Australia, until it finds some moist spot where the plant can again take root and let fall its seeds.

Still more complicated and beautiful than the wings already seen are the tufts of down seen on many fruits and seeds, and they serve a similar purpose. This down, which forms Dandelion 'clocks' and Thistle 'blows,' consists either of simple hairs, or those provided with a feathery arrangement. It may be found

attached to either the fruit or the seed. In the latter it may cover only a part of the surface, or it may entirely envelop the seed.

A tuft of hairs developed from the *seed* is usually called a *coma*, from a Latin word signifying 'hair.' As one example of such seeds, we may select Willow-herb, whose rosy flowers fringe our river-banks and ditches—plants almost always found in wet or marshy districts. Each seed is tufted with silky hairs, and the opening pod, containing several of these, is a very beautiful object. We are all familiar with the cotton-like hairs that show the presence of the seeds on the numerous kinds of Willow trees in early Spring or Summer. Here the seed nestles amid an almost perfect envelope of hairs. The *Asclepias*, or American Milkweed, has seeds tufted at one end, like those of our own Willow-herb. The cotton of commerce consists of long, hair-like cells from the seeds of *Gossypium*, the Cotton-plant, one of the *Malvaceæ*, or Mallow Order. Each thread is really a cylindrical cell, often very long, which, when dried, flattens out and twists spirally. By this peculiar outline, cotton can always be detected under the microscope.

When the hairs form a tuft on the *fruit*, we speak of them collectively as a *pappus*, from a classical word signifying 'an old man,' in allusion to the grey colour.

The ripe carpels or fruits of Pasque-flower Anemone and of wild *Clematis* are furnished with a feathery tail, which is in reality the long style covered with silky hairs. The long, feathered, graceful fruits of *Clematis* festoon our hedges in Autumn, and are known popularly as Old-Man's Beard or Traveller's Joy, and are among the most lovely of our country sights. In the Red Valerian of our gardens, now wild in many places, the *calyx* unrolls, after flowering, in the shape of a feathery cap for the fruit, which can thus be easily carried about by the wind. If you examine a single fruit from the thick, dark-brown spike of Reed-mace or Bulrush (*Typha*), you will see that it ends below in a very delicate stalk, around which, at three or four different places, arise a series of circles of fine silvery hairs, which support the tiny fruit in the air. The softness of the spike is due to the presence of multitudes of fruits, each provided with these hair circles.

The Cotton-grass of our moors is another example. It is not a true Grass at all, but is the genus *Eriophorum*, belonging to the *Cyperaceæ*, or Sedges. Its fruits have a tuft of long, silky hairs springing from the base, and we often see a marshy landscape white with thousands of these hair-covered fruits. You must not confound this with the Cotton-plant above named.

The *pappus*, as an air-floating device, however, reaches the climax of beauty and adaptation in the *Compositæ*, the Order including Thistle, Dandelion, and very many other plants. Examine a head of Dandelion early in its history, and you see nothing of any *pappus;* but look at it later on, and you will see in the place of the many florets that made up the so-called 'flower,' a spherical collection of beautiful hairs, which form the 'clock' of the children. Each single fruit is prolonged above into a long stalk or beak (very much longer than the fruit itself), at the top of which is a close-set circle of delicate hairs arranged laterally, so as to form a kind of parachute, *concave* above. This parachute bears up the fruit and acts as a sail for it, and, being by far the lighter end of the whole, causes the fruit to fall to the ground in the best position for its burial—namely, with the *fruit* itself downward. Most assuredly, this wonderful contrivance for dispersing the seeds is the reason why Dandelion is as common as it is. "A common weed!" we say. Exactly; and it is a common weed because it is a highly-adapted type, as Grant Allen tells us.

In the Hawkweeds—relations of Dandelion—the *pappus* is not raised on a beak, but is close down on the fruit, and is not so widely expanded, being more funnel-shaped. In Dandelion and Hawkweed the hairs are simple; but in the *Thrincia* of our lawns (which some people will call Dandelion, but which is only a near relative), they are every one feathered. This is carried to the furthest point in *Tragopogon*, or Goat's-beard, called 'John Go-to-bed-at-noon' by country folk, because it closes at mid-day. Here the hairs are not only feathery, but the feathery branches interlace all round the circle, so as to form a very powerful propeller under the influence of a breeze.

All these contrivances, whether found on fruit or seed, are evidently developed by natural selection, in order to the better dispersion of the life-containing germ.

One curious set of cases deserves a passing word while speaking of hairs. Several seeds, and also some fruits (*e.g.*, some Sages and Groundsels), are coated with short hairs containing spiral threads coiled up inside them. The hairs are usually pressed close to the seed or fruit, and kept down securely by a fibre of mucilage. The wind carries these seeds to some favourable soil, the dampness loosens the mucilage, the hairs spread out, are ruptured, and discharge the contained threads. These are highly elastic, and on protrusion fix the seed in the soil quite securely. Here, then, hairs serve to *arrest* the seeds or fruits, after dispersion. The mucilage present on the seeds of Flax and Cress probably does similar duty when moistened by the damp soil.

III.—ANIMALS.—Just as animals play a large and important part in the fertilization of flowers, so we find them taking their share in the dispersion of seeds and fruits. I cannot here give a tithe of the instances in which this is seen. A few must suffice. They perform their mission in different ways—some voluntarily, some unconsciously. While Insects chiefly assist in fertilization, Birds and Mammals are the principal agents in the work of dispersion.

Fleshy fruits are attractive to animals, because they serve as food. In these cases, therefore, the dispersion comes about by voluntary action. Three characters come into prominence when we consider this class of fruits—colour, fleshiness or juiciness, and hardness.

Colour has long been recognised as operating largely in the direction of dispersion of fruits and seeds. The æsthetic side of a Bird's nature is by no means undeveloped, as we may see in many ways, and we know that Birds are strongly attracted by the beautiful and varied hues of a large number of our wild berries and fruits. As we should expect, these colours are not developed until the fruit is ripe, or nearly so. It would, of course, operate injuriously, were it present at an immature stage, and Nature always takes care that during the time when a flower or a fruit needs protection, it shall be so clothed or enclosed as to be inconspicuous and non-attractive. When, on the other hand, fertilization is desired, colour and odour are laid under contribution in order to induce Insects to visit the *flower;* when dis-

persion becomes necessary, colour and sweetness of taste in the *fruit* come into play, to attract the animals of larger growth.

Again, colour, to be of service, must, as a rule, be distinguishable at a distance. Accordingly, we find that fruits develope tints that are easily set off against the background of green leaves, such as red, black, yellow, or white. Red is by far the commonest colour, varying from pink to scarlet or deep crimson. Between twenty and thirty of our native edible fruits have some shade or other of red. Among these may be named Strawberry, Raspberry, Barberry, Rose, Rowan-tree, Dogwood, Honeysuckle, Holly, Arum, Asparagus, Lily of the Valley, and others. Next in frequency comes black, or hues closely approaching it—*i.e.*, dark green or dark purple. For instance, Blackberry, Sloe, Alder, Bilberry, Elder, Plum, Ivy, Privet, and Buckthorn. Of white fruits, Mistletoe, Myrtle, and Snowberry furnish examples. I can only, for the moment, think of one actually yellow native fruit—the Sea Buckthorn of our east coasts: but we often find yellow blended with other tints on the same fruits, as in Apple and Pear, and there are some yellow seeds, as in Corn-flag, which are seen when the vessels open and expose them to view. Yellow, although a showy colour, would seem to lack the power to attract, and so is for the most part absent.

Not only has colour in fruits gradually developed itself in response to animal selection, but *fleshiness* or *juiciness* is traceable to the same cause. The soft, juicy pulp is both pleasant to the taste (in most cases) and good for food. Accordingly, colour having served to attract, juiciness, and in many instances *sweetness*, steps in to satisfy. The Birds have found out that the two pretty much go together, and they take care to use their knowledge. Colour is the sign-board hung out to give notice of the delicious fare to be found inside.

Different parts of the plant share in the provision of the dainty, tempting food. In Strawberry, where the tiny fruitlets are gritty and inedible, the receptacle, or tip of the flower-stalk, enlarges by degrees into the red, juicy, sweet mass known to us all, and thus the fruits are devoured for the sake of the pulp in which they are embedded. In Raspberry and Blackberry, the

fruitlets themselves are juicy and sweet, and being thus better fitted to attract, we find that these plants possess fewer seeds, fewer being needed, since each one of the cluster can assert itself by means of its rich pulpy envelope. In Rose, we find fewer still; the brightly-coloured hip—a development of the receptacle, hollowed out to contain the *fruits* (not seeds, these being inside the fruits)—presenting sufficient attraction in itself, both from its colour and composition. In Whitethorn, with only two seeds, each well protected by its own bony covering, we find perhaps the greatest attraction for Birds, especially Robins. Here the calyx-tube forms part of the fruit. In Cherry, the outer part of the single fruit becomes juicy, as also in Plum, belonging to the same Genus.

Colour and juiciness having done their part, we next find that *hardness* operates to prevent Birds from damaging the *seed*. Nearly all the seeds of these fleshy fruits are protected by some tough or stony covering, such as the outside layer of the minute Strawberry fruits, or the stone of Cherry, Plum, or Hawthorn. In other cases, the outer layer of the seed itself is sufficiently tough to resist attack.

In cases where the seeds themselves are edible, we often find them shut up within an envelope which is more or less bitter, as in Walnut, Beech, and the two Chestnuts. These are refused by Birds, and the edible part of the seed is stored away to form food for the tiny embryo-plant. Even where these edible seeds are sought for, as by Squirrels, dispersion is very often effected, for many are dropped in transit, and others are forgotten and left to germinate away from the parent-tree.

Birds disperse seeds in two ways. Either they carry off the fruit and, devouring the juicy covering, drop the hard seed to the earth; or they swallow the fruits whole, as in Strawberry or Raspberry, and the indigestible seeds are dropped in the ordinary manner. We can easily see how powerful a method of dispersion is afforded by Birds. Thrushes, going from North to South in berry-time, must carry thousands of seeds to deposit them in the warmer climate. The American Currant (*Phytolacca*) was long ago introduced artificially into Bordeaux, its berries being used to colour wines. It flourishes now all over Southern France and

Switzerland, and is by no means rare in the Tyrol, carried to these districts by Birds.

Animals act as dispersers unconsciously, as I have already said. Many fruits possess hooked processes in the shape of curved hairs, or spines, or prickles. These become entangled in the wool or fur of Sheep, Cows, and other animals, and are thus effectually carried away. Of these, examples are seen in Wild Carrot, Bur-parsley, Hedge-parsley, Burdock, Agrimony, Avens, Enchanter's Nightshade, Hound's-tongue, Cleavers or Goose-grass (familiar to everyone who has clambered through a hedge), and some Forget-me-nots. In Burdock, the hooks are on the scales of the involucre surrounding the flowers, so that one hook being caught carries away several fruits, which further, each possess a *pappus*. No wonder we find Burdock everywhere. Some seeds themselves are similarly hooked—the large Stitchwort, for example, which decks nearly every hedge-bank in April.

Some foreign genera, such as the Mexican *Martynia*, or Devil's Claws, possess horns three or four inches long, and *Martynia* well merits its name by the way in which it attaches itself to horses' tails and irritates the innocent proprietors. Others, like *Plumbago rosea*, are viscid, and stick to animals by this means. In *Myzodendron*, a South American parasite, whose brilliant flowers and fruits brighten the dark Patagonian forests, the fruits are provided with three long, feathery, *viscid* appendages, and, either carried by Birds, or wafted by breezes, to some tree, they fasten themselves to a twig until germination ensues, and then grow up into plants, feeding on the juices of the tree, where they have taken lodging and board without so much as "by your leave."

IV.—RUPTURE.—By this I mean the various methods by which seed-vessels—*i.e.*, fruits—dehisce, or open, of their own accord, either in part, when the wind usually shakes the seeds out, or through their entire length, in which cases the contained seeds are more or less forcibly expelled. In this latter case, there is complete self-dispersion, whereas in the former, the opening of the vessel is the only part of the process entirely performed by the plant. Let us first glance at a few cases of complete self-dispersion.

In Bitter-cress (*Cardamine hirsuta*), a very common weed on dry, open banks, the pod, at the proper moment, when the seeds are ripe, suddenly rolls its two side-walls outwards and upwards, and the seeds, lightly attached to a central delicate membrane, are scattered six or seven feet away from the plant. Even a puff of wind is sufficient to effect this purpose. Wallflower acts similarly, but with less force, as may be seen in any garden.

Among our wild Geraniums there are many interesting cases. Herb Robert, which everyone knows, has five seed-vessels arranged around a central elongated column. Each vessel is prolonged upwards into a thin rod, which is at first attached to the column, but is slowly separated from it; the flower, which after blossoming turns downwards, now becomes erect, the rods become highly elastic, and presently separate from the column with great force, often scattering themselves and their attached vessels to as great a distance as twenty feet. We may find scores of these flowers in the woodlands, each of them with the erect central column alone remaining, perfectly bare, and we must look for some time to find the scattered seed-vessels far away.

In another, *Geranium dissectum*, or Jagged Crane's-bill, the rods remain clinging to the column together with the five vessels, the *seeds* only being thrown off. Curiously enough, the vessels split open on the side turned *towards* the central column, and it would almost seem as if this were useless, but the plant has its fashion of overcoming this difficulty. Just before the vessel splits, the rod curls outwards, placing the vessel horizontally, and so at right angles to the column. The vessel gradually opens as the rod curls still more upwards, a delicate fringe of hairs keeping the seed safely meantime, until, when the rod has gone far enough to place the vessel nearly upside down, the hairs give way, and the seed is ejected. In this species, therefore, we should find the column, not bare, but surrounded at its top by the five curled-up rods, each carrying its empty vessel with the inner face split and looking upwards.

In Dog Violet (*Viola canina*), the capsule is raised on a long stem, and at maturity opens by three valves, each holding a row of four or five seeds. The walls of the open valves now

become dry, and contract, the two edges approaching each other. This, after a time, forces the seeds out with a jerk, throwing them eight or ten feet off. In Sweet Violet and Hairy Violet (*V. odorata* and *hirsuta*), the capsules are not so raised, the stem being almost absent, and the leaves all springing from close to the root. Here, we find that their capsules simply open as they lie on the ground, suffering the seeds to fall out among the grass near by. Not being raised aloft, if the capsules *shot* their seeds, the latter would probably strike against the surrounding grass and fall back again, so the valves develope no contracting power, such being useless, and they simply open quietly. Dog Violet has found a better device for dispersion, and so in many generations has gradually developed a tall stem, from the top of which its elastic capsules can do their work with good effect.

In Common Balsam, or 'Touch-me-not,' the pod dehisces through its whole length, and at maturity, if we gently press the centre between the thumb and finger, it swells up under our touch, parts suddenly, and away go the seeds. I have stood at one end of a room twelve feet long, and by pressure caused a pod to throw its seeds with force against the opposite wall. Again, go and look at some of our Vetches, or at Broom in seed-time, and you will find the pods split in two, with each half rolled or twisted on itself, and the seeds gone. The pods possess a layer of woody tissue at an *acute* angle to their axis. When this contracts, the pod is, therefore, not curled up along its length, but twisted, like a screw. Gorse, and some others of the Pea Order, open with a sudden crackling noise, and shoot out the seeds. On a hot August day you may stand by a clump of Gorse bushes and hear a series of tiny reports, as one by one the pods burst.

Two singular instances are worth notice. The fruit of the Sand-box tree (*Hura crepitans*) of America is about as large as an orange, with a dozen or more deep furrows, which indicate as many internal divisions into carpels. When ripe, and under a hot sun, each separate carpel splits simultaneously, the whole bursting with a loud explosion. From this fact, the plant has earned the *soubriquet* of the 'Monkey's Dinner-bell'!

Squirting Cucumber (*Ecbalium elaterium*) is one of the Gourd Order, and when ripe is full to tension of a viscid fluid. A

very slight touch causes it to suddenly separate itself from its stalk, the sides contract, and through the end where it was attached, the whole contents, both fluid and seeds, are sent with a whizzing sound some feet in the air. An unwary traveller, touching *Ecbalium*, may quite easily obtain a baptism not to his liking. Intense heat causes spontaneous separation from the stalk without any touch. These examples of complete self-dispersion may suffice.

Of the cases where a partial dehiscence takes place, we may name a few.

Mouse-ear Chickweed (*Cerastium*), found in almost any wild spot, has its capsule tilted laterally at the tip, and opens by ten minute teeth. The seeds rest safely until a high wind comes along, when they are shaken out and carried away. This places it in a superior position to that of ordinary Chickweed (*Stellaria media*), which opens all the way down, the seeds falling on the adjacent ground.

The beautiful Red Campion, with its bottle-shaped capsule, also opens by ten teeth, and is admirably fitted for wind-dispersion. The Catch-fly of our corn-fields, Pink, and Primrose, open in similar fashion.

Another method is that of pores, or tiny circular holes near the top, through which the seeds escape under the action of wind after the plant has opened its 'windows.' These may be seen in Mignonette, Snapdragon, Toad-flax, Canterbury Bell, and notably in Poppy, where the overhanging edges of the circle of stigmas protect the openings. The pores themselves are said to close in wet weather. This I have not, as yet, ascertained to be the fact myself. In those Canterbury Bells whose fruits are *pendent*, the capsules open at the base, which is of course uppermost in these cases. We see, therefore, that it is a useful provision that ensures the capsules opening *above*, so that the seeds may remain prisoners until the wind acts on their capsules, and afterwards on themselves, to carry them far afield.

In Pimpernel and Plantain the capsules open by a circular line entirely round the fruit, the top part coming off like a pill-box cover. Here, again, the wind can act when the seeds are ready for it.

Besides these four chief methods of dispersion, there is one other occurring in a few cases and deserving of notice. I refer to *movements of the plant itself—i.e.*, of some portion of it.

Dandelion, after lying horizontally among the grass while ripening its seed, rises to an erect posture, thus enabling the wind to act on the parachute-like *pappus* surmounting the fruit. On the other hand, many plants, by their movements, provide not for dispersion of seeds by wind, but for burial of them in the soil. The small white Subterranean Clover (*Trifolium subterraneum*) of our commons and downs is a good example. Here, instead of the large number of florets seen in a head of purple Clover and others, only about three of the bunch become well-developed florets with pods; the rest remain abortive in a sense—*i.e.*, they are developed into a number of short fibres, each having four or five divisions like the fingers of a hand, but of course very minute.

These palmate fibres together form a small green knob in the centre of the flower-head. The whole plant lies close to the ground, except that at blossoming-time the three florets stand erect to secure fertilization by the Bees. This accomplished, the stem lengthens and turns downwards, the palmate fibres are developed, and, being central, on touching the earth they bury themselves with a screwing sort of movement, thus working a hole, into which the three pods (which have by this time bent downwards) are drawn and effectually buried. Thus the plant safely stores away its pods, full of seeds, which ripen underground during Autumn and grow up in Spring. The plant, growing only on ground quite closely cropped by animals, in this way secures reproduction by burying the pods safely out of harm's way. It sacrifices some of its flowers in order to make natural gimlets, which can dig a grave for the three seed-bearing ones!

Many other plants, possessing the usual aërial pods, have also some subterranean ones, usually shorter and with fewer seeds, the smaller number being an advantage, as they the more easily flourish when trying to germinate close to one another, while in the aërial pods a larger number of seeds evidently secures a better chance in the scattering process. Of these plants we find examples in some species of Vetch, Vetchling, and Cress. In

American Earth-nut (*Arachis hypogea*), the 'nut,' so called—in reality a pod—is buried while still unripe, and later on, underground, developes its two seeds. If the burial for any reason be not made, the pod withers, and no seeds are produced.

Some cases exist in which *movement of the seed itself*, after it has left its capsule, either scatters or buries it. The seed of Wood-sorrel (*Oxalis*) ruptures its *testa* or coat, expelling the body of the seed with violence. The Stork's-bills, belonging to the *Geranium* Order, possess seeds which develope a hairy, twisted 'awn,' which, under given conditions, principally of moisture, unrolls and pushes the seed down into the ground, the awn itself being kept fixed by surrounding herbage.

Stipa pennata, a pretty European Grass, has seeds with a corkscrew rod and long feather springing from their apex; the whole arrangement is over a foot long, and in moist weather the unrolling of the rod acts as in the Stork's-bill seeds, the feather probably serving the purpose of carrying the seed, first of all, to its resting-place.

The *elaters*, contractile filaments forming part of the spores of the Horsetails, act in somewhat similar manner, by fixing the spores to the earth, and in some water-weeds the spores are furnished with vibratile cilia or fine hairs, enabling them to move in the water spontaneously, and so disseminate themselves.

We have now seen the various agents and contrivances by which seeds are placed in favourable situations for growth, and we cannot fail to be struck with the wonderful adaptation and ingenuity of many of them. That the wings, or the hooks, as the case may be, are not mere accidents or ornaments, as some would have us imagine, but exist for the purposes named, is, I think, fairly established by looking at the kinds of plants on which they are found, and considering their stature. Sir John Lubbock, in a most interesting paper in the *Fortnightly* for April, 1881, gives us the two following statements (I quote them in outline only):—

1.—"Roughly speaking, there are some 30 genera, belonging to 21 different Orders, having seeds or fruits with wings. They are all trees or climbing shrubs; not one is a low herb. That is, they all occur in situations where the wind has free access to

them. If the wings were merely accidental, why do we not find them on low-growing shrubs and plants?"

2.—"There are about 30 English species where dispersion is effected by hooks, causing the fruits or seeds to adhere to the coats of animals. If these hooks were simply ornamental, or present by accident, why do we never see one such hooked fruit on a water-plant or a tall tree? What is the actual fact? Out of these 30, not one is aquatic; not one is over 4 feet high; not one grows at a level *below* that at which seeds would be likely to get entangled in the fur of animals, having reference to the usual size of British Mammals."

Thus approached, the 'keys' of Ash and Sycamore circling through the air, the silvery down of Thistle and Dandelion, the rich, deep crimsons and purples of our woodland fruits all have meanings for us; we behold in all of them additional evidences of the great truth of Natural Selection, by means of which, through countless ages, the Great Designer has slowly and certainly evolved the myriad forms and colours of fruits and seeds that call for study and attention; and we look with wonder and delight on them all, as, with perfect adaptation of construction to purpose, fruit and seed are sent forth far and wide, on their beautiful mission of regeneration and abounding life.

The influence of the moon upon vegetation is an interesting problem awaiting solution. A recent writer upon the subject mentions that woodcutters in Cape Colony and in India insist that timber is full of sap and unfit to be cut at full moon. Another observation of lunar influence in Cape Colony is the rapid spoiling of nuts and other provisions when exposed to moonlight, though this may be due to the fact that the light serves as a guide to insects.—[The editor, from many years' residence in Essex, is well acquainted with the fact that no farmer's wife (of the old school, at any rate) will pickle hams in a "waning" moon. The days between new and full moon are chosen by the farmer to kill hogs for home consumption, because, they say, the meat will swell with the moon, but in a waning moon it will similarly decrease. Is this custom noticed in other counties?—Ed.]

Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part III. Plate XIII.

IN our last article mention was made of the various stages of development occurring up to March 21st—that is, about three weeks after the egg was deposited; in the present paper sections will be given of a single animal as it appeared on March 17th. These are numbered in succession, 1, 2, 3, 4, and 5, number 3 being as nearly as possible a median section, whilst 1, 2, and 4, 5 are two sections on each side of it respectively.

The first thing which strikes us on looking at these sections is the enormous development of the brain and spinal cord in comparison with the size of the entire animal. The nervous system fills up the whole upper portion of the cavity of the skull, extending down nearly to the cavity of the mouth, and behind stretching out as a thick cord to the very extremity of the body. When we compare this with the relative size of the brain and spinal cord as existing in the adult frog, it will be at once seen that an immense amount of both concentration and diffusion must occur between the present and the adult stages—concentration in the approximation of the various portions of the nerve system to each other, and a possible diffusion by portions of the nerve matter spreading out so as to produce nerve-cords extending over the body.

Whether the whole of the nervous system is developed from the nerve-matter at present formed, or whether fresh portions of yelk assist in the formation of nerve substance will probably be seen in our future sections. The length of the brain itself—extending as it does from the very front portion of the head, quite back to the segmented sheath surrounding both the spinal cord and notochord—is much greater in proportion to the whole nervous system in the embryo than it is in the adult. Thus, at the present stage, the cerebral lobes, medulla oblongata, etc., are at least as long as the remainder of the nerve-cord, but in the frog the latter, within the vertebral column, must be quite three times the length of the true brain, even if we include the olfactory lobes as a portion of it.

In our present sections it is easy to distinguish, not only the cerebral hemispheres and the medulla oblongata, but also the mid-brain, the optic, and olfactory lobes, as well as in section 2 what I believe to be the pineal gland. The whole of the brain and spinal cord is bounded by a single layer of apparently epiblastic cells placed end to end, so as to form a delicate membrane around it. The fore-brain, also, is at this period well marked oft from the mid-brain by a slight depression and a hollow space within the substance of the brain itself (Fig. 2, *pn.*) It is here, just above this depression, that a small oval body is situated, terminating in front immediately over the hollow or ventricle above mentioned, but extending backwards slightly over the mid-brain. This oval body is in all probability the pineal gland. If this be so, there is, however, no trace of the eye-structure recently found in the pineal gland of some reptilia, unless, indeed, the very considerable depression itself, which exists between the epidermis and limiting membrane of the brain at this very spot, and which is well seen in another section, of the same animal, not given in these drawings, can be taken in connection with the small detached mass of nerve matter as evidence of the existence of an undeveloped eye.

The membrane enveloping both brain and spinal cord at this stage would appear to be the commencement of the pia mater. All the organs are, however, surrounded by a similar, though in some cases more delicate membrane. Thus, the abdomen can be distinctly seen to be bounded by three layers, the innermost of which is bent round in the neighbourhood of the heart to form a large closed chamber, corresponding to the pleuro-peritoneum of the adult, the whole of the already-formed organs being on the one side, and the undifferentiated yelk-mass on the other of this membrane. From the lower side of the spinal cord, at intervals along its length, small processes of nerve-matter can be seen to be extending through the membranous wall; and beneath and around these again cartilage can be perceived to be forming. The spinal cord is at this period perfectly double throughout its whole length, and rests upon the notochord, an elastic fibrous sheath, about which more will be said hereafter, binding the two structures together, although in some of my sections, from which the ligament

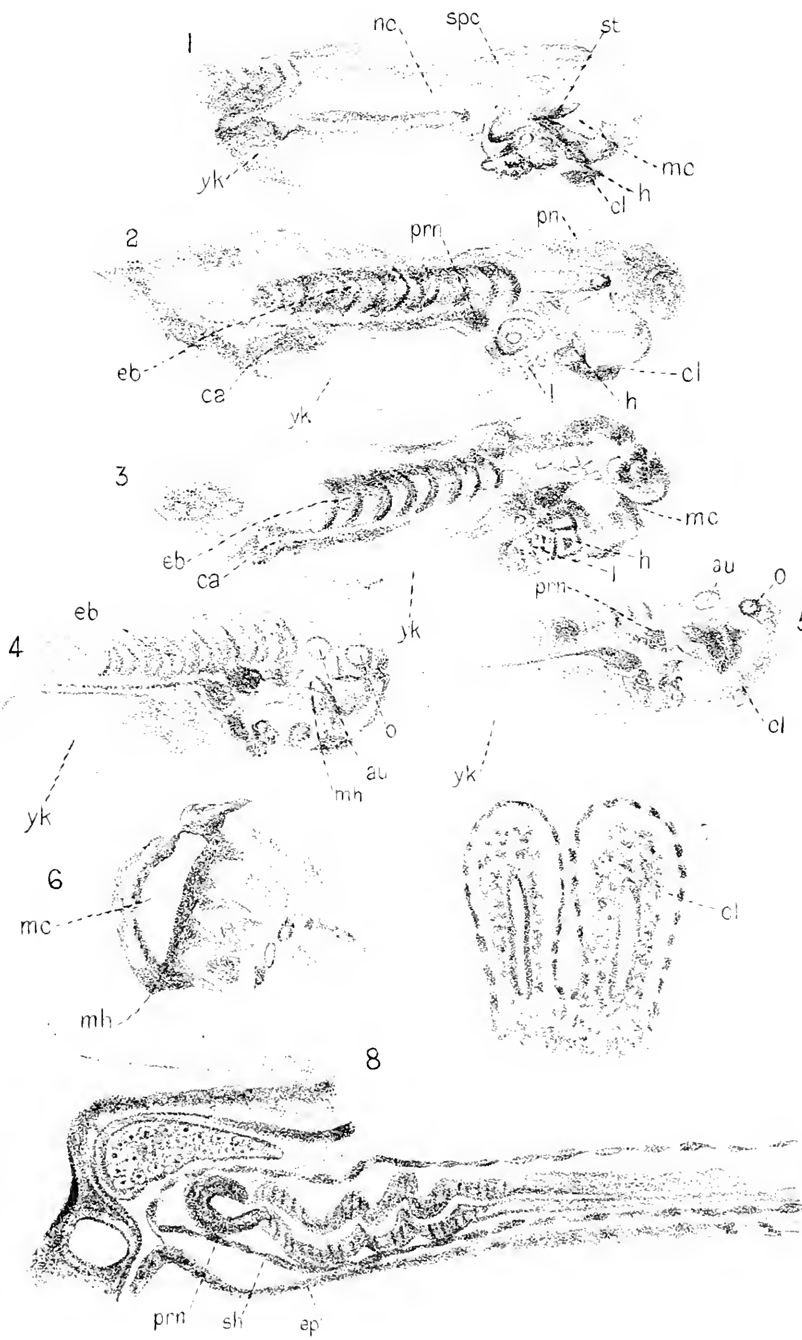
has been entirely removed, there appears a distinct line of separation between them. Balfour, in his embryology, tells us that the posterior roots of the spinal nerves arise from the dorsal, and the anterior roots of the same from the ventral side of the spinal cord. These anterior and posterior roots, although at first separate, ultimately coalesce to form the true nerve-cord.

In sections 1, 2, and 3, we see one stage in the development of the heart, lungs, kidney (or pronephros), and liver. The heart is at this period peculiarly interesting, consisting, as it does, of a pear-shaped sac, situated below, and a little to one side of the mouth-cavity, within the pericardium. It is an open tube, bounded by muscular walls, consisting distinctly of two rows of cells placed end to end, so as to give somewhat the appearance of transparent rows of beads, threaded on an opaque, granular, and elastic string, nearly the same size as the beads themselves. The inner row represents the epithelial lining of the heart, whilst the outer layer gives rise to its muscular wall. The interior of the sac contains several round, granular cells, looking very like undifferentiated yelk-cells, but very much smaller and quite round. Attached to the upper portion of the sac, and towards the mouth-cavity, one of the sections shows another sac, formed exactly on the same principles, consisting, indeed, of a double tube, the wall on one side conterminous with the wall of the heart, and the inner tube filled with granular matter. The pear-shaped body has exactly the shape of a ventricle, whilst the other fairly well represents the position of the auricles, but as there is no distinct connection to be traced between this structure and the heart, besides their close approximation, it very probably represents a young stage in the development of the lungs. The granules within the pear-shaped body are distinctly arranged in the form of two lines crossing each other, with little groups scattered about. Between the heart and the undifferentiated yelk-mass lies the liver. The rudiments of this organ make their appearance very early; indeed, traces of it are to be found in the animals whose sections were given in the last article.

In sections 2, 3, 4, and 5, may be seen, just under the notochord, an apparently granular structure, of which a much-enlarged vertical section is seen in Fig. 8. This is the immature kidney, or

pronephros. It consists of a convoluted tube, terminating in a glandular hollow bulb. Further sections of this tube show its structure to be more complicated than that given in the diagram, as the lower sections proved the existence of several of these bulbs, some round, whilst others were oval, and one or two possessed the appearance of a dumb-bell, with a very short, wide handle between the knobs. The tube and its openings is entirely surrounded by a membranous sheath, consisting of long, elliptical cells. The convoluted tube or duct is itself composed of a large number of flat, oval cells placed closely side by side, having much the appearance of an immense number of tiny, flat pebbles, arranged side by side, with their flat faces touching each other and their rounded edges pointing upwards. The internal portion of the cells appears considerably darker than the external; indeed, the appearance is such as would be presented by a very minute layer of epiblastic cells, surrounded by one of hypoblastic; but whether this is the case I have not been able to determine, as there appears no definite line of demarcation between the dark interior and lighter exterior of the tube-wall, such as should be due to the approximation of these two different classes of cells. This primitive kidney is the same structure, more fully developed, which was shown in Fig 5, Pl. VII., and there called a pro-renal duct.

Götte states that the development of this duct commences from a layer of the peritoneal epithelium, its front end being, as here shown, immediately behind the branchial arches, and also that it has free communication, by means of its openings, into the body-cavity. Doubtless, this communication really exists, but at the stage to which we have arrived it can only be through the delicate membrane, if a single layer of cells is deserving this name, which surrounds the whole organ, and separates it from the body-cavity. Indeed, in a section four days older than the one drawn, two of the openings are seen to lie directly against the membrane, but the section does not enable me to make out whether they are actually under it or open up into it. These openings have all the appearance of the end of a thickened tube, looking like a thick, dark ring surrounding an opening of about the same diameter as the thickness of the tube-walls.



Development of Tadpole

In the whole of our sections there will be seen, on the under part of the head, a dark mass, *cl.*—called the claspers—an enlarged horizontal section of which is given in Fig. 7. They are hollow bodies, evidently outgrowths of the epidermis. The central cavity is bounded internally by a row of very small, dark cells, and radiating from these are larger, elongated, black cells, which stretch in fairly parallel masses nearly to the outside of the structure, the whole being covered by the polygonal cells of the epidermis. The two parts of which they are composed approximate very closely to each other, if they are not, indeed, in actual organic connection, by means of the epidermis, but at a certain period of their growth they are distinctly separate. Although these commonly-called claspers are referred to by embryologists as suctorial discs, I cannot find any opening into the interior whereby suction can be carried on by them. Nevertheless, that such an opening exists would appear probable, unless, indeed, they are not suctorial discs at all, but claspers in the true sense of the word. From the yelk being situated in the abdominal region, combined with the cavities in the head, the animal must necessarily take an inclined position in the water, head uppermost, whilst the comparatively great weight of the abdominal regions drags the animal downwards in the water. The claspers will now press laterally on anything, as, *e.g.*, parts of the gelatinous envelope or external objects, which may mechanically find their way between them, the animal being merely held in position by the combined effects of the greater specific gravity of its lower parts and the slight adhesion which takes place between the so-called suctorial discs.

EXPLANATION OF PLATE XIII.

Figs. 1—5.—Sections from one Tadpole, taken March 17th.
,, 6.—Mandible arches.
,, 7.—Claspers.
,, 8.—Pro-renal Ducts and Lungs.

Sp.c., spinal cord ; *nc.*, notochord ; *m.c.*, mouth-cavity ; *h.*, heart ; *st.*, stomach ; *al.*, alimentary tract ; *ca.*, cloaca ; *cl.*, claspers ; *l.*, liver ; *e.b.*, elastic band, surrounding notochord and spinal cord ; *prn.*, pronephros, or immature kidney ; *sh.*, sheath of ditto ; *m.h.*, mandibular and hyoid arches ; *o.*, optic vesicle ; *au.*, auditory capsule ; *b.*, brain ; *ep.*, epidermis ; *pn.*, pineal gland ; *ga.*, ganglia.

Preparations for High Powers.

By J. W. Gifford.

WITHIN the last few years, and especially since the Abbé-Schott glass has come into requisition for the construction of lenses, the optical capabilities of the microscope have been so much increased as to make microscopical research rather a question of methods for the more careful and exact preparation of the objects to be examined than of further advance from an optical point of view.

Dr. Lionel Beale was, I believe, the first to point out that by the ordinary method of fixing in spirit, staining, and mounting in balsam, many points of minute structure are lost. His glycerine carmine fluid for fixing and staining tissues at once has become classic, and was composed as follows :—

Carmine	...	...	10 grains.
Liquor ammoniæ	...	...	$0\frac{1}{2}$ drachm.
Strong Glycerine	...	...	2 ounces.
Distilled Water	...	...	2 ,,
Alcohol	..	...	$0\frac{1}{2}$ ounce.

The carmine is dissolved in the ammonia by heat in a test-tube, and then allowed to stand until the excess of ammonia has escaped. The other ingredients are then added, and the whole filtered. Perfectly fresh material is immersed in this for a period of time varying from six to twenty-four hours, according to size and temperature. The material is then washed in glycerine and water, and placed in glycerine acidulated by acetic acid (ten drops to the ounce) for several days. It may then be cut with Valentin's knife, or teased out, and mounted in glycerine, with a trace of acetic acid.

All things considered, there is no doubt that as a general method this still stands second to none, especially where tissues, such as a piece of mesentery or a minute ganglion, do not require to be cut into sections, but may be mounted as they are or teased out with needles. But sections cut with Valentin's knife are scarcely suitable for examination with high powers, and in order

to enable thin sections to be cut with a modern microtome, the material for cutting must be imbedded. This may, of course, be accomplished by placing the material in gum solution and freezing in the ordinary way, but, as Dr. Beale has pointed out, once allow the tissues to leave glycerine or syrup, and change immediately sets in, and the whole advantage of the process is lost. Besides, the crystals formed by the freezing of pure gum solution more or less break up all delicate structures. If, however, gum and syrup be used as recommended by Mr. Cole, or a small quantity of glycerine be added to plain gum, change is prevented and the crystals are so finely granular as not perceptibly to injure the most fragile tissues. I think the gum and glycerine is to be preferred. Both syrup and glycerine retard freezing. Glycerine quite prevents it, unless a small quantity only be used, and as the strength of glycerine varies this must be ascertained by experiment.

Sections thus made are mounted in glycerine jelly, prepared as follows :—

Glycerine	...	...	150 grammes.
Isinglass	...	...	30 ,,
Water ...	...	...	q.s.

Dissolve the isinglass in as little water as possible, using gentle heat, clarify with white of egg, strain through muslin, add the glycerine, and keep the whole for some days at about 60° C. until the greater part of the water has evaporated. In this way a very highly refracting jelly may be made. Preparations mounted in glycerine, as recommended by Dr. Beale, after a year or more become exceedingly translucent, so that minute points of structure, particularly intra-nuclear networks, can no longer be distinctly made out. This is not the case with glycerine jelly. As little heat as possible should be used in mounting, or the sections shrink. After the cover-glass is put on, and all superfluous jelly cleaned off, the mount may be ringed with gold size, which is, I think, the most reliable of any cement for this purpose.

But where very faithful and instant fixing *in statu quo* is required, I think a slight modification of Flemmings' chromo-aceto-osmic acid is the best fixing agent, although on account of its feeble powers of penetration it can only be employed where

the material is thin or can be cut into very small pieces. To a watchglassful of ⅛th per cent. chromic-acid solution, made with distilled water, sufficient osmic acid is added to make it smell distinctly, and finally one drop of formic acid. The material—immediately after death, in the case of an animal—is placed in this for from half-an-hour to two hours, according to size; that is to say, for as short a time as will ensure thorough penetration of the mixture, which may with advantage be slightly warmed. It is then soaked in several changes of water, to which a little glycerine has been added, and stained in a mixture of equal parts of Kleinenberg's hæmatoxylin and glycerine. The formic acid may be omitted, but delicate nerve-plexuses are not so sharply brought out, and it is then far more difficult to stain. The material should remain in the hæmatoxylin two days, and should then be placed in a mixture of equal parts of glycerine and water, and kept lukewarm for a week or longer, until most of the water has evaporated. It may then be mounted whole, or frozen and cut by the process before described, and finally mounted in glycerine jelly. The nuclei amid the protoplasm lining the cells of *Anacharis alsinastrum* may in this way be beautifully demonstrated and compared with a living leaflet exhibiting cyclosis, where the nuclei are indistinguishable from the protoplasm.

I have tried many methods of preparing delicate tissues for examination with oil-immersion lenses of the highest aperture, but have found these the only ones which give me certain results and enable me to use these lenses with advantage. They are certainly troublesome, and have not the charm of novelty, but enable an aperture of from 1·3 to 1·4 to be effectively employed, and I think will be found successful in direct proportion to the care used in carrying them out.

Fumigation is said to have originated with Acron, a physician of Agrigentum, who is said to have caused great fires to be lighted, and aromatics to be thrown into them to purify the air, and thus to have stopped the plague of Athens and other places in Greece about 473 B.C.

Numerical Aperture.

By the Hon. J. G. P. Vereker.

A LETTER has appeared in the *Scientific Enquirer* asking for information on the connection between numerical and angular aperture, and also for an explanation of the mathematical terms used.

It would take too much space to write a reply to this query, giving fully the proofs of the theorems, and also explaining all the mathematical principles involved; but I shall endeavour to give here a slight sketch of the various points.

First of all, the connection between angular aperture and numerical aperture is very simple:

Let $a = \frac{1}{2}$ the angular aperture of a lens.

Let $m =$ the refractive index of the medium between the lens and the object,

Let $N =$ the numerical aperture.

Then $N = m \sin a$.

Sin a is a contraction for the sine of the angle a, and if the value of a is known in degrees the value of sin a will be found in mathematical tables under the head of Natural Sines. I have, however, appended a table of natural sines for every 5° of the quadrant.

The value of m is only required for a few substances in microscopy, and I give them here:—

Air	1·000.
Water	1·333.
Abbé's Immersion Oil	1·520.
Canada Balsam } Crown Glass }	1·530.

It will be remarked that crown glass, of which the front lens of an objective is usually made, and Abbé's immersion oil, have about the same refractive index; therefore an oil immersion lens is also called a homogeneous immersion lens.

The next point is to explain the mathematical terms used, and to give a slight sketch on refraction.

Let F A X (Fig. 1) be any angle, and let us call it A. From

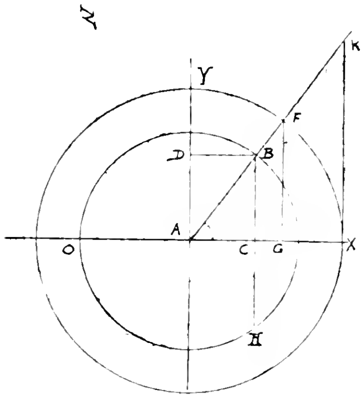


FIG. 1.

the point A, with any radius, describe a circle B H O, cutting A F in B. From B let fall a perpendicular B C, on the other leg of the angle A, and produce B C to meet the circle in H. Then B C is called the sine of the angle A to the radius A B, and is (Euclid III. 3) half the length of the chord B H. With the centre A, and another radius A F, describe any other circle; through F draw F G parallel to B H, and meeting A X in G; then F G is also the sine A to radius A F. But by Euclid VI., 4:—

$$B C : F G :: A B : A F,$$

therefore $\frac{B C}{A B}$ is a constant quantity for the same angle. Now this fraction $\frac{B C}{A B}$ turned into decimals is what is written down in mathematical tables as the natural sine of the angle A, which is itself given in degrees.

The angle A in the figure is less than a right angle, but it might be greater. By a similar construction it will be seen that $\sin A = \sin (180^\circ - A.)$ This is, however, unimportant for us, as in objectives the semi-angle does not exceed 90°.

If through A, A Y is drawn perpendicular to A X, the angle $Y A F = 90^\circ - A$, and is called the complement of the angle A and is equal to the angle A B C (Euclid I., 23). Its sine, B D, is

equal to A C, and is called the cosine (written cos :) of the angle A.

$$\therefore \frac{A\,C}{A\,B} = \cos A.$$

Through X, draw X K perpendicular to O X, and meeting A K in K ; then the line K X touches the circle T F X, but does not cut it, and is called a tangent. Now, X K is the tangent of the angle A to the radius A F, which is equal to A X.

$$\therefore \frac{K\,X}{A\,X} = \frac{B\,C}{A\,C} = \tan A.$$

The co-tangent, written cot., is the tangent of the complement of A.

Therefore, if B A C is a right-angled triangle, having the right angle at C,

$$\frac{B\,C}{A\,B} = \sin A; \quad \frac{A\,C}{A\,B} = \cos A; \quad \frac{B\,C}{A\,C} = \tan A.$$

It is evident also that $\tan A = \frac{\sin A}{\cos A}$, and also that when A is *very* small the sine is almost equal to the arc subtending A.

For example, the length of the sine 3° in a circle of 10 inches radius is ·523 inch, and the length of the arc is ·524 inch. The difference therefore is $\frac{1}{1000}$ of an inch.

We can now proceed to the chief law of refraction.

If a piece of string is made fast to a nail in the wall and held loosely by the other end in the hand, and a slight up-and-down motion given to the hand, the particles of the string are given an up-and-down motion, and it is thrown into a series of elevations and depressions, and the string *apparently* moves on, though, as a matter of fact, it does not. This is called an undulatory, or wave movement, from the familiar example of the waves of the sea. Light is propagated in the same manner, but the movement is believed to be a double one, at right angles to each other, as is shown by experiments with polarised light. The propagation of light takes place slower in a dense medium than in a rarer one.

Now let M N (Fig. 2) be the limiting surface between two media of different densities, and let A O B C be a parallel beam of light striking it obliquely, and let A O meet M N in O, and

B C meet it at C. From O draw O D perpendicular to B C, and meeting it in D; the line O D will represent the tangent to the advancing waves. Now, when the wave advancing along B D has reached C, the wave advancing along A O has entered a certain distance into the second medium; and this distance has the proportionate length, to the length D C, that the speed of advancement in the second medium has to that in the first; with the centre O, and this multiple of the distance D C, describe, a semicircle, P H L. In Fig. 2, *a*, this distance is smaller than D C,

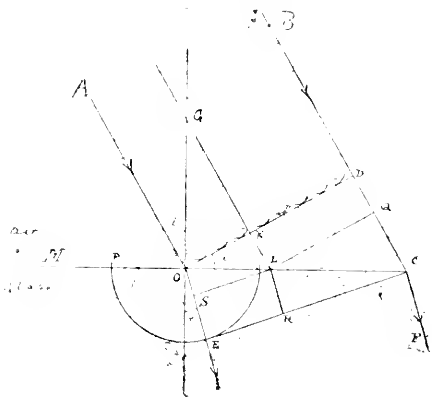


FIG. 2, *a*.

and in Fig. 2, *b*, is greater; (in fact, the two figures are drawn to

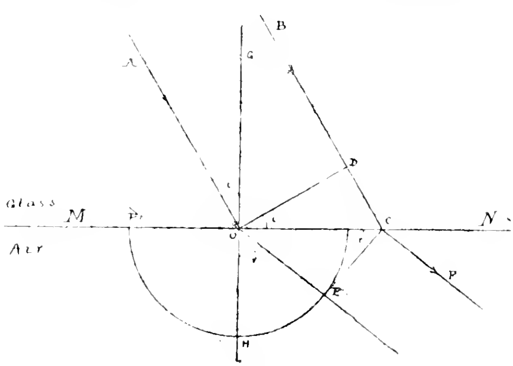


FIG. 2, *b*.

cale, and represent the passage from air into glass and from glass into air.) The wave advancing along A O must have got to some point on this semi-circle by the time the wave along B D has reached C: from C draw a tangent, C E, to the semi-circle, touching it in E join O E. Then C E represents the tangent to the advancing waves in the new medium, for take any other wave direction in the beam, represented by K L, and meeting M N in L; draw L R parallel to O E, meeting E C in R, and L Q parallel to O D, meeting B C in Q, and L S parallel to C E, meeting O E in S. (This is only drawn in Fig. 2, *a*, to avoid confusion of lines.)

Then

$$\left.\begin{array}{l} O L : L C :: O S : L R \\ O L : L C :: K L : Q C \end{array}\right\} \text{Euclid VI., 4}$$

$$\therefore O S : L R :: K L : Q C.$$

$$O S + L R : L R :: K L + Q C : Q C.$$

$$O E : L R :: D C : Q C.$$

$$L R : Q C :: O E : D C.$$

Or, the distance L R is the right amount of advance in the new medium for the wave along K L, whilst the wave along B C is covering the distance Q C; that is to say that C E represents the tangent to the advancing waves in the new medium.

Through O draw G H perpendicular to M N. Then the angle A O G is called the angle of incidence, and the angle H O E the angle of refraction.

$$\text{Let angle } A O G = i,$$
$$\text{and angle } H O E = r$$

Then, since A O D is a right angle, and G O C is a right angle, take away the common angle G O D, then i = angle D O C. Also, since angle H O C is a right angle, and angle E O C + angle O C E are equal to a right angle; take away the common angle C O E; therefore, r = angle O C E.

$$\text{Now, } \frac{D C}{O C} = \sin i, \text{ and } \frac{O E}{O C} = \sin r$$

$$\therefore \frac{D C}{O E} = \frac{\sin i}{\sin r}$$

But $\frac{D C}{O E}$ is the ratio expressing the speed of propagation of light in the two mediums, and is constant; there is, therefore, an

invariable ratio between the sines of the angles of incidence and refraction.

The value of the fraction $\frac{D\,C}{O\,E}$ when light passes from air into another medium, is what is known as the refractive index of the substance; this makes the refractive index of air unity.

It is evident from the figures that rays perpendicular to the surface M N suffer no deviation, but are only retarded.

If m be taken as representing the refractive index of the passage of light from air into another medium, the refractive index of the passage of light from the other medium into air is the reciprocal of m, or $\frac{1}{m}$; for the two parts of the refracted beam are mutually dependent; this is easily deduced from the figures. Therefore, the passage of light from a medium into air is given by

the equation, $\sin i = \frac{\sin r}{m}$

If $r = 90°$, the radius is equal to the sine, and $\sin r = 1$; in this case the refracted ray lies along the surface of the medium.

Take, for instance, the case of crown glass.

$$\text{Then } \sin i = \frac{1}{m} = \frac{1}{1 \cdot 52},$$
$$\text{or } i = 41° \; 8\tfrac{1}{2}' \text{ (nearly).}$$

This angle is called the critical angle of glass, and a ray having a larger angle of incidence cannot pass out, and is totally reflected. The critical angle of water is 48° 35′.

From this it follows that an angle of

$$90° \text{ (air)} = 48° \; 35' \text{ (water)} = 41° \; 8\tfrac{1}{2} \text{ (glass)}$$

in the amount of light-rays it contains; so that the denser the medium the more the rays of light are squeezed together.

Now let A B (Fig. 3) represent the section of a lens. This may be either a single lens or the front lens of a system. Let D C be drawn perpendicular to the lens, and passing through its centre. Then D C represents the principal axis of the lens; and let F represent its focus, and A F and B F represent the extreme boundaries of the cone of light-rays from F, passing into the lens. Then the angle A F B is called the "*Angular Aperture*" of the lens.

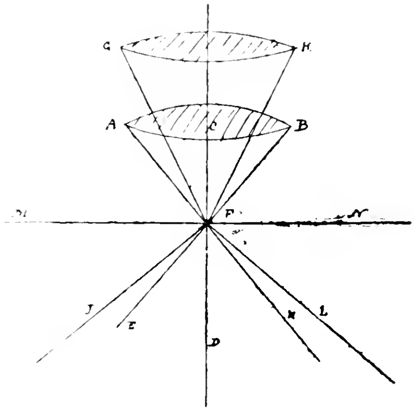


FIG. 3.

Produce the lines A F and B F through the focus to E and K. Draw M N through F, perpendicular to D C. Now, the angle E F K is equal to the angle A F B, and if air is on both sides of M N will represent the angular amount of light coming from air into the lens, but if there is *another medium* instead of air, the angle E F K will not represent it.

In the case of the microscope, if a medium is placed between the lens, it is always a denser one than air, and consequently angle A F B represents a much larger angle in air, such as J F L.

For, let m = refractive index of the medium.
Let a = angle A F C = $\frac{1}{2}$ A F B.
Let b = $\frac{1}{2}$ angle J F L.
Then $\sin b = m \sin a$.

Thus, it is necessary to take the angle J F L as the true angle of aperture for the whole cone of rays, because if the cone of rays represented by A F B are fully utilised, they are re-given out in air.

The actual amount of light, of course, varies with the squares of these quantities; but, as in all microscopical work, it is found more convenient to treat of linear equivalents.

Taking the same figure, suppose G H to be a lens of the same diameter as A B, with a longer focus, but still at F, and G F H

representing its angular aperture, it is evident that its angular aperture is less than that of A B. This shows that focal length is an element in the calculation of aperture.

If a lamp with a circular ground glass globe is looked at, the part perpendicular to the eye is seen to be brighter than the edges; but if the sun or moon is looked at they seem equally bright all over, and this in spite of the fact that equal visual angles take in more of the surface radiating light at the edges than perpendicular to the eye: the investigation of these phenomena, and of light emitted from an infinitesimal bright surface element has given rise to the Lambert law, which shows that the amount of light given out does not depend on the ratios of the angles, but on the sines of their inclination to the perpendicular. For example, take an angle of 60° and an angle of 120° round the perpendicular. Then $\frac{120^\circ}{60^\circ} = \frac{2}{1}$ and the amount of light is not as $2^2 : 1 = 4 : 1$; but as $\frac{\sin^2 60}{\sin^2 30} = \frac{3}{4} \div \frac{1}{4} = \frac{3}{1}$, or light from 120° : light from 60° :: 3 : 1.

All these points show that the *angle* of aperture is insufficient of itself to give a correct notion of the performance of a lens, but that some function of this angle is required.

The word aperture simply means opening, and what we want to get is the lineal opening of a lens, which lets the light through, so as to be able to compare lenses together. The size of this opening has already been shown to vary with the focal length; that is to say, the longer the focal length the smaller the aperture for the same diameter of lens, so that, if

o = this opening,
f = the focal length,

we want to find the ratio of o to f.

The next question is, Where shall we measure this lineal opening? If we measure the front lens, some of the light may be cut off by diaphragms or in other ways; that is to say, the light might come in, but never get out again. The only useful rays are those that get out, and as they get out into air we get rid of refractive indexes. Therefore, the rays emerging from the back lens are the ones to measure. There is another advantage,

that the rays emerge approximately parallel, so they give a clear idea of an opening or aperture.

A convenient place to choose for the proof I am giving is the moment when they have just emerged.

Let G C and H D (Fig. 4) be the exterior and interior faces

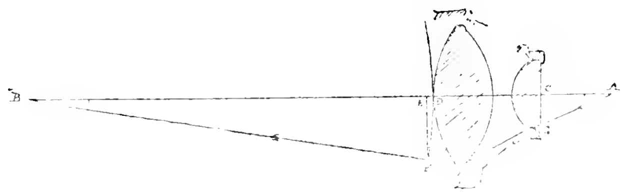


FIG. 4.

of an aplanatic system on the plane of the paper and the line B A represent the principal axis of the system, meeting each face in C and D. Let A and B be two conjugate foci, and A G any ray of light which passes through the system, and is refracted along H B to B; then by the Abbe-Helmholz law of aplanatic convergence,

$$\frac{\text{Sin B}}{\text{Sin A}} = \text{a constant} = c,$$

as long as the same focus and system are considered. Let the refractive index on the A side be m and on the B side unity, that is, air; then if a and b represent the ratio of the arc to the radius of two very small conjugate angles lying close to the axis, and E represent the magnification of the image at B by the Lagrange Helmholz law,

$$\frac{a}{b} = \frac{m}{\text{E}}.$$

If the focal length of the objective be f and the image is projected to a distance, d,

$$\text{E} = \frac{d}{f} \text{ (nearly)}$$

$$\therefore \frac{a}{b} = \frac{mf}{d};$$

but as the sines of *very small* angles are equal to the ratio of the arc to the radius, and as the first equation holds good for all angles,

$$c = \frac{mf}{d}.$$

From B, and with a distance, d=B D, describe an arc cutting B H in F. The waves of light must touch this circle simultaneously to arrive along the equal radii at B together. From F let fall F E perpendicular to B D, and meeting it in E, then F E will represent the linear semi-opening $=a$ and B F=B D=d.

$$\frac{a}{d}=\sin B = c \sin A = \frac{mf}{d} \sin A,$$

$$a = mf \sin A,$$

$$\frac{a}{f} = m \sin A.$$

Now, if the ray A G F B represents the most oblique ray which passes in and out of the system,

$$\frac{a}{f} = \frac{o}{2f} = m \sin \tfrac{1}{2} \text{ angular aperture};$$

or the ratio of the linear semi-aperture of any system to the focal length of that system is equal to the sine of $\frac{1}{2}$ angular aperture multiplied by the refractive index of the medium between the object and the lens. This is the numerical aperture.

As the angle B, in the case of the microscope, is always *very small* if the arc F D or the tangent to H D was taken, the difference between their ratios to the distance B D and that of the sine F E would be inappreciable, so this aperture is half the clear opening of the back lens.

∴ If half the angle of aperture is represented by a, and N is the numerical aperture,

$$N = m \sin a$$

In the case of a dry lens m is of course unity.

There may be a slight feeling of dissatisfaction at taking

$$E = \text{the magnifying power} = \frac{d}{f};$$

but as a matter of fact this *exactly* expresses what we mean by an objective of a certain focus.

For instance, take a ⅛ objective. We know this objective does not focus a ⅛ inch away from the object. We mean, however, that its magnifying power is that of a lens whose focus is in a certain ratio to the distance of distinct vision, which is always taken

as 10 inches, and the magnifying power of this lens is supposed to be 80, that is to say,

$$\frac{10}{f} = 80 \text{ or } f = \frac{1}{8} \text{ inch.}$$

This number, 80, multiplied by an ocular magnifying 5 times (A ocular) gives the magnifying power 400, and this holds good for all the other powers.

The rule for the magnifying power of an objective is, divide 10 by the focal length in inches, and multiply the quotient by the power of the eyepiece.

In the case of *minute* objects, some of which are transparent and some opaque, the waves of light pass round them, or through them, or both together, and thus may cause a disturbance in their undulations. In this case images known as Diffraction Images are formed.

In viewing minute objects it is important to combine as many as possible of these images; but these images are dispersed at various angles from the perpendicular to the surface, and in a denser medium than air these angles are of course reduced according to the index of refraction, which proportion is given in the formula for numerical aperture. An immersion lens therefore can take more of these images in, and thus has greater resolving power.

Take, for instance, a lens of 170° angular aperture; this, if a dry lens, has a numerical aperture of 0·9962, but if oil immersion of 1·514224, or the oil lens has more than half as much again resolving power as the dry lens, though the dry lens is working almost at its maximum. This could never have been inferred from the angular aperture alone.

If the wave-length of green light is taken as $\frac{1}{50,000}$ inch (this is a point between E and F in the spectrum) the numerical aperture, multiplied by 100,000, will give a theoretical resolving power in lines to the inch, which is often very convenient, though of course rather rough.

For example: required a lense to resolve Amphipleura Pellucida, which contains about 90,000 lines to the inch. To 90,000 add a tenth for errors, etc.; this makes 99,000; divide by 100,000. This gives N A $= \cdot 99 = \sin 82°$ for a dry lens, $= m \sin a = 48°$ for

water immersion. That is, the angular aperture ought to be 164° for a dry lens, or 96° for a water lens. Now for the power. Say the eye-piece magnifies 10 times, and you want it resolved 100 lines to the inch, divide by 1,000, and you get

$$\frac{10}{f} = 99 \text{ or } \frac{1}{10} \text{ inch will answer.}$$

I trust the above will give sufficient of the information required. I have dwelt at length on refraction, as it seems to me that it is there that so much misconception has crept in : it being so difficult to see why different angles in different media may mean one and the same thing. Diffraction I have only mentioned, as it would lengthen this article inordinately, and has also nothing to say to the measurement of aperture.

TABLE OF NATURAL SINES TO EVERY 5°.

Angle.	Sine.	Angle.	Sine.	Angle.	Sine.
5°	0·0872	35°	0·5736	65°	0·9063
10°	0·1736	40°	0·6428	70°	0·9397
15°	0·2588	45°	0·7071	75°	0·9659
20°	0·3420	50°	0·7660	80°	0·9848
25°	0·4226	55°	0·8192	85°	0·9962
30°	0·5000	60°	0·8660	90°	1·0000

The Villi and Beading Discovered on Butterfly and Moth Scales.

By Dr. Royston-Pigott, M.A., F.R.S.

Plate XIV.

NOW that glasses of great power can be cheaply obtained, a completely new field of enjoyment is to be found in the examination of the Villi and beading of these scales, mounted dry.

In 1881, a short notice on Villi was published by the Royal Society. Since that time, the writer, having mounted about 450 species and spent most of his leisure in their investigation, has the pleasure of announcing about 12 varieties of these Villi at present.

In 1880 they were with much difficulty descried on the scales of the *Red Admiral;* but recently much larger and prominent Villi have fortunately been discovered. They may be classed as *internal*, lying between the two membranes forming a scale; *external*, sometimes penetrating the inner membrane from within, attached to the ribs and peeping outwards in an extraordinary variety of forms, generally tipped with brilliant heads; *superficial*, being distributed in most grotesque forms upon the surface of the scales next the wings.

Some further description of scales is here required. They are all ribbed on the outer or air surface and, excepting the Villi, smooth where they rest upon adjacent scales. Another point should not be omitted. They are all saturated with a peculiar scale-oil, which may by pressure be made to play a prominent part by developing structure as it flows to and fro within the sac. It has a very strong preservative power, and refuses for an immense time to evaporate.*

These little wonders are best seen when a small portion of the scale adheres to the cover-glass and when the ribbing lies below.

A very exact vertically-measuring apparatus records some of the Villi erected, 1—5000th of an inch, but generally they are only from 1—10,000th to 1—8000th aloft above the unribbed membrane which lies compactly upon the wing.

* I have some Podura scales, 60 years old, quite full of this oil still.

Manipulation.—I have long known that the apparent thickness of the black margins of cylinders and spherules depends upon two factors—angular aperture of the objective and of the illuminator.

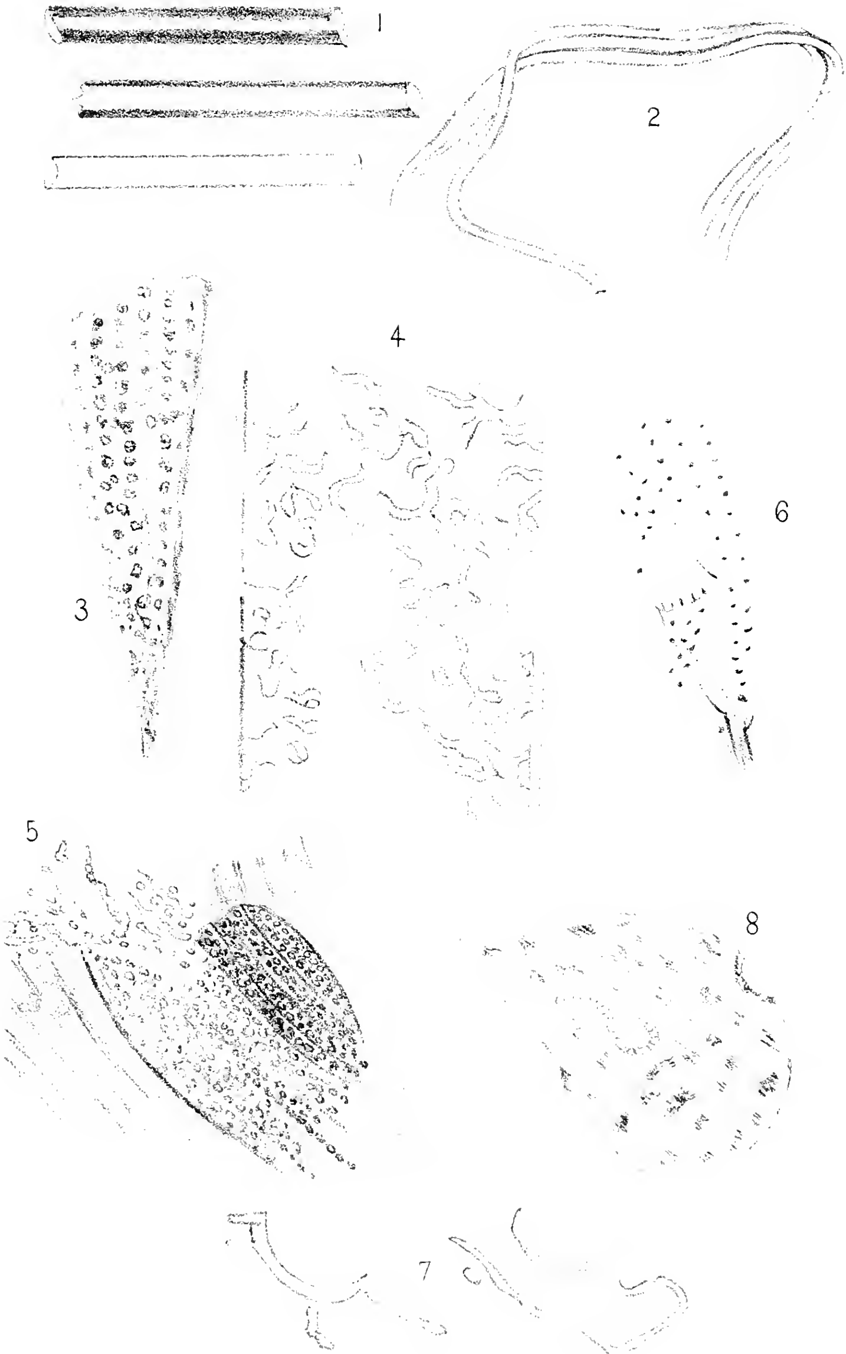
The outlines are seen thinnest with a wide-angled condenser, such as Abbe's, and seen very thick by a low-angled one, such as a one-and-a-half-inch Ross's objective. Objectives of many kinds have been successfully employed as condensers for many years; also an Iris diaphragm and Powell's stops. In practice, a touch of the hand rapidly reveals the best apertures for superb definition.

Battledore scales require magnificent glasses to display the beading on their surfaces. But very ordinary ones show the well-known circular dot; better ones descry pillars with oddly-shaped bases connected *internally* by filaments, and if the focal depth be sufficiently delicate, single pillars, which indeed are huge villi, may be traced within, downward from head to base. To show what can be done by the best modern glasses, the other day, examining the Battledores of *Polyommatus Bœticus*, the quill or stem was seen glittering with the most minute, diamond-like beading, evidently intended to secure the quill safely in its place, the wing pocket.* I have seen this in no other species.

The types of villi lately discovered are in themselves highly interesting:—*Batonettes*, *Vermiforms*, *Confluents*, and *lofty Erectiles*. Besides these, eight other kinds had been previously discovered:—*Beaded Villi*, *Embossed Villi*, *Ciliated Villi*, *Connected Villi*, *Banana or bunched Villi*, *Spinous Villi*, *Tall Villi*. There can be no doubt that many other varieties exist, and perhaps, after another seven years' search, new kinds may be discovered. By the permission of the Editor, a few of these will be represented by drawings. Mr. Watkins, King's Mill House, Painswick, supplies a list and wings.

* I extract an entry from my catalogues:—

"Supplied by Mr. Curties, scales (*a*, *b*, *c*, *d*, *e*). Nearly all the scales show ribs and Villi downwards, but scale (*a*) shows the other surface beautifully jewelled with beading, especially the quill. When the ribs are shown upwards, the bosses appear and are prolonged inwards. A 1-32nd was used at last to differentiate the two membranes (Feb. 8th, 1881.) I reckon this minute beading at 1-150,000th of an inch in diameter."



Villi in Scales of Lepidoptera

EXPLANATION OF PLATE XIV.

Figs. 1 and 2 represent the *broad* margins seen in spider lines and glass threads under small apertures, which narrow as the apertures are increased.

,, 3 is a very precise drawing of a burst-open scale in which the minute beading is beautifully represented (after Nature), which I here term embossed Villi, *Zygæna Trigonilla*.

,, 4 shows the effect of pressure. The Villi, formerly erect outside the scale, are here demonstrated as flattened down. *Zygæna. Trigonilla*.

,, 5 displays a very *recherché* definition of Molecular beading, about 1-90,000th of an inch in diameter, under a power of 2,100 diameters, abounding in minute spherules defined by their sharp outlines or test rings.

,, 6.—A scale accidentally torn open by the process of mounting dry. The ribs are revealed underneath, and the rent-piece, still attached, shows villi adherent to the torn membrane and visible both externally and internally under the microscope. This butterfly wing came without a name, and I call it "No name." No. 102. It is a *Zygæna*.

,, 7 represents some of the infinite forms of erect Villi, power 2,000.

,, 8.—Most wonderful variations of the forms of large Villi are to be seen on the under surfaces of the Battledores of *Lycæna Alsus*. One only is selected.

Mr. Hinton, 11 Vorley Road, Upper Holloway, has mounted a great number of Villi slides.

Drawn from Nature by Royston-Pigott.

Curious Deposits in the Cells of the Dahlia.—H. Leitgeb has published in a botanical journal a curious account of the Crystalline deposits in Dahlia tubers, and these may possibly be met with in other plants of the same group, many of which are used in pharmacy. In order to exhibit what he terms the "spæro-crystals of inulin," sections of dahlia tubers are usually soaked in alcohol. The author having allowed a tuber to soak for several years in this liquid, finds the spheres of inulin with radial stripes grouped in the peripheral region of the tuber. Besides these, he has noticed spheres that are composed of an amorphous nucleus, surrounded by an envelope formed of radiating needles. These crystals, he tells us, abounded in the pith and inner portions of the parenchyma. On being burnt they leave, after complete combustion, a mineral residue of the same shape as the crystals, consisting of phosphate of lime. The amorphous nucleus is not inulin, nor fat, but some organic substance, the nature of which is unknown.

Embryo of a Parasitic Entozoa from a Human Tooth.

By Jabez Hogg, F.R.M.S., M.R.C.S., etc.

QUITE lately, a medical friend requested me to examine and report on an interesting microscopical specimen, which it appears had "puzzled" him a good deal, and he was therefore the more anxious to learn something of its natural history. The "worm," as he termed it, was removed from the tooth of a domestic servant, who had suffered some time from toothache and neuralgic pains of the face. The removal of a molar tooth afforded only temporary relief. At the end of three or four months, and on finding medical remedies of no avail, she met with a gipsy, who recommended her "to smoke the worm out of the tooth with henbane seeds." She obtained the seeds, and having placed them, as directed, on hot cinders, allowed the fumes to pass into her mouth. In a very short time, "six or eight worms dropped out of her teeth into a tumbler of water." This for a time seems to have afforded her relief, but as the pain again returned, and for which remedies proved unavailing, my friend, on one of his visits, induced her to use the henbane fumigation in his presence. In a very short time, "a minute worm" wriggled from the mouth, and was caught in a tumbler of water. This he carried away with him, and on his return home put it up in a temporary cell, which was sent to me for examination. I may first say that, so far as I know, no precisely similar case has been well enough authenticated to be placed on record. Accounts have appeared, and to the effect that violent attacks of toothache have been traced to a "worm" lodged in the cavity of a decayed tooth. Furthermore, it has been said that the "worm" has been "smoked out," as in the instance related, by henbane seeds. Such statements have hitherto been regarded with a good deal of incredulity by the medical profession. I may mention, however, that I have met with two or three well-authenticated cases of "worms" lodged in the nasal cavities, and there producing alarming symptoms, which have subsided after the worms were dislodged by tobacco smoke.

It is no uncommon error, which my friend has fallen into, of describing the specimen sent to me as "one of the worms." It is, however, neither a worm nor a maggot, but a veritable embryo of a parasitic entozoa. It belongs undoubtedly to the Trematoda or fluke family, a class of animals well known to infest mankind as well as the lower animals. The puzzle in this case is, How did embryos of the fluke find their way into the patient's decayed tooth? Probably in one of two ways. In all likelihood the ova of the fluke will have been conveyed into the mouth and stomach by eating tainted or infected animal food, the liver of a sheep suffering from fluke; or the eggs may have been taken in infected, polluted drinking water, more frequently, however, in diseased meat, fish, or fowl, which during the masticatory process is left behind and safely lodged in a hollow tooth or an exposed portion of the alveolar process, there to be retained until more fully developed into the wriggling embryo, which was finally dislodged by the henbane fumigation. It is quite within the bounds of possibility that the patient may have unwittingly suffered from ascarides. In such a case, the ova or embryos, during their ordinary larval wanderings in search of a final resting place, which shall prove suitable for their adult condition, might find their way back to the stomach, throat, and mouth of the sufferer.

No fluke arrives at sexual maturity before passing through a cercarian stage of existence, while its tailed or larval form is usually acquired by passing through an intermediary host, a molluscan, or water animal. It may be a fish. The little water-snail, *Limnæa truncatula*, is undoubtedly the host, in its transition stage, of the liver fluke of the sheep, and the amount of these snails, seen at certain periods of the year about marsh lands, in river water, in cisterns, and ponds to which cattle and sheep resort to allay their thirst, is enormous.

Altogether, five specimens of the dislodged larval flukes were sent to me; four of them, however, owing to the want of proper precautions for their preservation, were spoilt, being completely covered over by the mycelia of a minute fungus. The cover-glass also of the mounted specimen was broken in the post, so that I heartily wished my medical friend had been a member of

the Postal Microscopical Society. With a little difficulty I finally succeeded in remounting the young cercaria in balsam, thus rendering the body nearly transparent for microscopical examination. It measures nearly a sixth of an inch in length. Its head, which is of a pale yellowish brown colour, is terminated by a buccal opening of a contractile, sucker-like nature. The hyaline integument of the body throughout is broken up by a series of longitudinal and transverse markings, which presents an appearance of irregularly shaped, tesselated cells. The ventral opening is situated at the lower third, where a considerable cleft occurs, and here is seen to be the termination of a narrow gut, which runs from just below the buccal opening to this point, and is then lost to view. The lower third of the body constitutes what is nominally described as a tail-like appendage in the larval stage, and which is either broken off or absorbed in the fully-matured fluke.

Filaria have now been found in almost every cavity of the body, either in man, or in the lower animals, and it is not difficult to conceive how several of these minute embryos may have become lodged in the cavity of a hollow tooth of one among a class of persons who notoriously disregard the use of the tooth-brush.

The insect world is vast almost beyond our conception. The President of the London Entomological Society states that while Linnæus knew only 3,000 species of insects 120 years ago, the collections of the world probably include at present 200,000 or 250,000 species. Certain data lead to the inference that we do not yet possess more than one-tenth of those existing, so that even the present rapid rate of discovery will not complete our collections of insects in less than 1,000 years. Before the end of that period, many species of to-day will have become extinct, and the President urges that those likely soon to disappear should be especially sought.

The Pathology of Pollen in Æstivis, or Hay-Fever.

By Prof. Samuel Lockwood, Ph.D.

Plate XV.

CERTAIN places in the White Mountains of New Hampshire have become notable as summer resorts for sufferers from Æstivis, or Hay-Fever. A number of these sanitaria lie more or less contiguous to the sources of the Saco river, on the one side, and the sources of the Connecticut on the other.

When the South winds prevail in either of these long tracts, there is a lowering of the barometer, and at the same time a nervous depression of the subjects of Hay-Fever. There is also another change in the atmosphere, which is then laden with the dust-produce of these valleys. A marked element in this dust is pollen, chiefly that of Rag-weed and Golden-rod, which, especially the former, abounds in the South, in the months of August and September. At such a time the suffering among the Hay-Fever guests is severe and general. Happily it does not continue, but passes off with the change of wind. On the theory of a *neurosis* the cause seems plain to me. With the sudden humidity of the atmosphere, and low barometer, the tonic of the mountain air is dissipated, and nervous depression results. Then, since the air in this condition is surcharged with pollen, and other impurities, the nerve endings of the respiratory passages are irritated unto acute inflammation.

At the closing session of the United States Hay-Fever Association. last September, at Bethlehem, N.H., a long-cherished desire was revived to learn the relative hygienic quality of the favoured sanitaria, and that of places where the malady prevails. Owing to my official relation, it fell to me to state the factors in such a determination.

The problem to be solved might be called the Hygiene of the atmosphere. It would involve, all through, consideration based upon instrumental work. This would need such records of the winds, humidity, range of the barometer and thermometer, as fall to the meteorologist. The impurities, organic and inorganic, of the atmosphere must also be considered, which side of the work

would fall to the microscopist. If density were added, this would cover all.

A word as to the conveyability of material particles by the atmosphere. There is something *ad captandum* in the splurge of the lugubrious poet :—

"The dust we tread upon was once alive."

But, in the present tense, how true is this of the dust we breathe! Can we not recall the painful interest excited by Tyndall's experiments on the impurities of the atmosphere? And, for our purpose, how easy to repeat some of them! Let a beam of sun-light through a hole in the shutter enter a dark room. It appears as a slanting, living column. I say *living*, for every particle seems in motion, due to the incessant dancing movements of millions of motes.

If now a small spirit-flame, yielding no smoke, be held under this beam, there will soon be seen a dark hole right through the column. Withdraw the flame, and soon the contiguous motes dance into it ; it is again illumined, and the dark hole disappears. If now we pass a red-hot bar through it, the beam will be divided into two parts by a black space. The bar withdrawn, soon the neighbouring motes dance into it, and the beam is all light again.

The deduction, for our purpose, is that the so-called impurities present are chiefly organic, and the heat burns them out. The spores, infusoria, and microbic matter are thus destroyed—the air literally being purified by fire.

All these things, even the mineral matter, constitute the aerial dust so distressing to the sufferer from Hay-Fever. And I hold that a prominent irritant in the air, during the Hay-Fever season, is pollen.

But what is pollen? It is the fertilizing granule produced by the stamens of a flower. These granules vary greatly in size and form in the different flowers. Some are smooth, others are angular, but those, with which this discussion will deal, are globular or elliptical, spiny, and very minute. Not noticing the pollen of the grasses, which particularly affect the early forms of the disease, perhaps the most mischievous of the pollens are those of the Rag-weed and the Golden-rods. I have here specimens of the plants:

Rag-weed, *Ambrosia artemisiæfolia*, L., and the Golden-rods, *Solidago altissima*, L., *S. lanceolata*, L., and *S. squarrosa*, Muhl., which three forms are typical. I have here also, under these microscopes, pollen of all these plants, mounted on slides; also here are enlarged drawings of the pollens.

Fresh Rag-weed pollen is very nearly spherical. The granule measures in these specimens, which are a little distorted by long drying, $\frac{1}{1200}$ inch in length by $\frac{1}{1500}$ inch in width. In a fresh specimen, or such as floats in the summer air, so fine are the points of the spines that they are to that of a cambric needle as it is to the point of a marling-spike, or even a crowbar. And yet this object, with its subtle armature, is literally invisible to the unaided sight. See Plate XV., Fig. 1.

The pollen-grains of the Golden-rods are sub-elliptical, both ends being of the same size. They are very spiny, and the spines are relatively longer than those on the pollen of the Rag-weed. They are of two lengths on the same granule. The pollen of *S. altissima*, the most abundant, in these parts, of the many species, is in length $\frac{7}{6000}$ inch, and in width $\frac{1}{1000}$ inch. The flowers are in a recurved panicle, not unlike the graceful spray of an ostrich plume.

An abundant species is the *S. lanceolata*, whose flowers are borne in scattered corymbs, or flattish-topped clusters, something in the manner of the Wild Carrot, which habit is in striking contrast with the Golden-rods generally. This pollen makes a narrower ellipse than the one just mentioned, the two diameters being $\frac{1}{1000}$ and $\frac{1}{1500}$ inch respectively.

S. squarrosa is less common than the other two species. The flowers are more conspicuous, and arranged in a showy wand, or sceptre-like spike. Its pollen measures $\frac{1}{800}$ by $\frac{1}{1000}$ inch, hence it is larger than that of *S. altissima*.

And exceedingly interesting is the end view, since it shows a tripartite disposition, being as it were depressed at three points. Now these depressions are simply the terminations of three longitudinal canals on the sides. The end view is shown in Fig. 2; and Fig. 3 shows one of the longitudinal grooves. I find these marks much fainter in *S. altissima*, and barely discernable in *S. lanceolata*.

We have now noticed three points which are pertinent to the discussion, as will appear, namely: the minuteness of these pollen-grains, their spiny armature, and the naked grooving at the surface.

1.—The first effect noticeable of pollen then is due to its presence in the air as an impurity. The granules are taken in at breathing, as a foreign element. Except that it is more pungent, their action is in common with that of other impurities—namely, suffocating. Advanced Hay-Fever is always more or less asthmatic, and impurities in the air will cause spasms, and in some instances even the odour of domestic animals will bring this about.

2.—But pollen, taken into the respiratory tubes, is a mechanical irritant. In severe Hay-Fever all the air passages are in a state of inflammation. The starting spot is in the vicinity of the nares. At first the patient does not dislike the tickling of the pungent grains of titillating dust. But it very soon becomes serious, and nature summons all the sternutatory forces to eject the intruders. So violent does this sternutation become, and so long continuous, that the blood is started from the nostrils. The mucous membrane of the nose and the immediate air-passages become supersensitive. In fact, the entire mucous surface is soon in a scalded state, and every nerve-ending is a participant of torture. Suppose a person's back to be in that state of eczema, in which inflammation has reached suppuration, and a thistle-bur to be put down the back. The rest may be left to imagination. Now suppose that a number of grains of pollen of Rag-weed, or Golden-rod, with which the air is laden, to be inhaled, when the whole nasal region and the ducts beyond are scalded with the incessant discharge of acrid secretions. Is not each one of these infinitesimal teasels a lacerator of the tender and inflamed membrane? Hence, when these enter in myriads, what a combination for exquisite torture! I have been caught in a place where Rag-weed pollen was prevalent in the air, and have been seized with sudden spasms, so violent that I have had to cling to a fence for support under suffering that was inexpressible.

3.—Besides being a mechanical irritant because of the spines, I am persuaded that pollen has a toxic quality in Hay-Fever. In

plainer words, it poisons the already inflamed tissues of the respiratory passages. No one doubts that, to some persons, skin-poisoning is a certainty, upon walking on the lee-side of the toxic Sumach, *Rhus venenata*, in its flowering time. Why not then a toxic effect of pollen upon the mucous linings already super-sensitive, and even lacerated by their presence?

In the old herbals the *Solidago*, as the word almost implies, had a reputation for vulnerable virtues, it being used in treating wounds. One of the species, *S. odorata*, yields an aromatic oil on distillation. It cannot, then, I think, be inert upon the surface of the inflamed and minutely lacerated mucous membrane.

The laceration facilitates the poisoning. But there is another possibility in this matter. The copious nasal secretions, acrid and warm—have they no power for extracting the toxic principle?

4.—And, lastly, I am constrained to believe that pollen, in Æstivis, is a vital automaton—that it can, as a living organism, perforate the mucous lining, actuated on the principle of a pseudo-instinct; not altogether unlike the Carrion-fly, when it deposits its eggs, by mistake, on the decaying, nitrogenous fungus, instead of putrid flesh. If we are to understand by instinct, "inherited experience," it is to be found even in plants. It is true that we are told *how* the Hop twines to the left, and the Scarlet-runner to the right, but back of the "how" lies the "why?" And occasionally we find a change of habit in an individual plant, as left-handedness is found among rational beings.

I must be permitted now to deal with some elementary ideas on the subject of fertilisation by the pollen-grain. In respect to the several pollens herein described, each must be regarded as a highly-organised cell, with a twofold shell—an outer rind, which is thick, and carries the armature of spines; and an inner one, which is thin, in fact, a membrane, which is exposed at the surface in grooves, spots, or pores, and these exposed places are always smooth. In the Golden-rods, as shown in the figures, these depressions are longitudinal grooves. The interior of the pollen consists of a viscid life-stuff, or protoplasm, whose function is to fertilise the ovule, at the base of the style in the pistillate flower. To effect this, a curious play of the life-force sets in. The style is composed in part of a loose, or more or less spongy tissue, while

the stigma at the top is charged with a saccharine, sticky mucilage. A pollen-grain, borne by the wind, or an insect, usually, now falls upon the stigma, and is anchored to it by the spines sinking into the gum. The moisture causes the grain to swell. There is a protrusion of the membrane at one or more of the thin places at the surface, whence a tube, or root-like process, emerges, and penetrates the stigma. It seems to be an extension in tubular form of the membrane, and is filled with the protoplasm of the cell. If the kid-glove on a lady's hand could be pinched at the back, and that nip of the glove pulled out or extended, and the flesh could flow into this extemporised little pipe, it would roughly represent the pollen tube. Having pierced the outer coat of the stigma, this tubule, by a sort of growth, keeps on lengthening, and pushing its way down through the loose tissue of the style, until it has reached the ovule at the base, when its mission ends, and the future seed of that flower is assured.

Now to return to my statement of mistaken instinct in the insect. Pseudo-instinct is also found in plants, even in the initial life-processes. The surcharged nectary of a flower may appear in a place approachable to a pollen grain. Should the granule alight upon that viscid spot, out would pop the pollen-tube, with the usual effort to pierce the epidermis of the flower, but in vain. Indeed, we can easily deceive the pollen-grain, by dropping it upon moistened sugar, and even witness this out-put of the tubule.

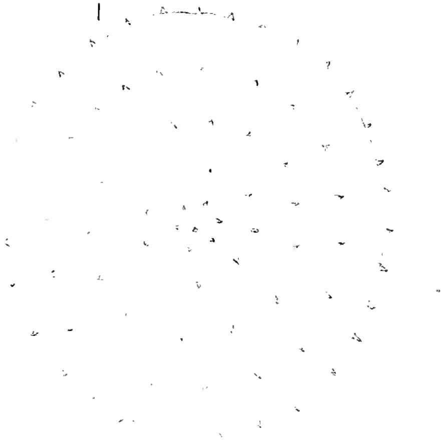
The point I would now make is this—that a similar pseudo-instinct prevails with the pollen-grain, when it is inhaled, and falls upon the moist and tender tissues of the inflamed linings of the respiratory passages. All the favouring conditions are there—moisture, softness, and warmth. Hence results an instinctive protrusion of the pollen-tube into the puffy, inflamed, and exquisitely sensitive tissues. I think this parasitical action has to do with that acute stinging sensation in the nostrils so frequent in Æstivis.

Thus have been instanced four possible modes of action for pollen in Hay-Fever.

1.—Its suffocating effect as an impurity of the atmosphere, thus exciting asthma.

2.—As a mechanical irritant begetting inflammation, even to excoriation of the mucous membrane.

1



2

3

4

3.—As a toxic agent, poisoning the tissues.

4.—As a pseudo-parasite, penetrating the soft and sensitive parts.

It should be added that these activities are here supposed to operate upon the system while in an abnormal state. In a word, behind all there is a Hay-Fever neurosis. As the nasal ducts are the first to show suffering in Hay-Fever, and the malady thence extends to all the respiratory organs, as well as other parts of the system, I think it bodes good that in addition to the long-known "Laryngological Association," the medical fraternity have effected a new organisation under the name "Rhinological." This new society is to concern itself with the ailments of the nose, hypothecating the fact that diseases of the throat and larynx almost always have their origin in the nasal region.

EXPLANATION OF PLATE XV.

Fig. 1.—Pollen of Rag-weed, *Ambrosia artemisiæfolia*, L.: size, $\frac{1}{1200}$ by $\frac{1}{1500}$ inch.

,, 2.—Pollen of Golden-rod, *Solidago squarrosa*, Muhl.: end view, showing spines of two lengths, and trilobate depressions ; size, $\frac{1}{860}$ by $\frac{1}{2000}$ inch.

,, 3.—Pollen of *S. squarrosa* : side view, showing one of the three longitudinal grooves, which in Figure 2 are indicated by the trilobes.

,, 4.—A diagram of a group of pollens of *S. squarrosa.* Two are side views, and six are end views.

The figures are necessarily diagrammatic. For Figures 1, 2, and 3, I am indebted to Dr. Alfred C. Stokes.

(From the Journal of the New York Microscopical Society.)

Mr. Fred. Enock, of 11 Parolles Road, Upper Holloway, London, has sent us a number of his very excellent Lithographic sketches by which his slides are accompanied. We have also received from him slides of vertical section through the cephalothorax and abdomen of the Garden Spider, *Epeira diadema,* showing the brain, heart, liver, spinnerets, silk glands, and other internal organs ; Head of Devil's Coach-Horse Beetle, *Ocypus olens*, mounted without pressure, showing organs of the mouth in the natural form and colour ; the Bed Bug, *Cimex lectularius*, showing internal and muscular structure ; and the beautiful Fairy Fly, *Camptoptera papaveris*, one of the smallest winged insects, being only about one-fiftieth of an inch long from head to tail. Mr. Enock's slides are the perfection of mounting.

Half-an-Hour at the Microscope,
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Plates XVI., XVII, XVIII.

Marine Diatoms, in situ (Plate XVI., Figs. 1—5).—This slide may be likened to a thoroughly good girl—homely at first sight, but constantly revealing new beauties as you seek to study her character. It shows some points in structure which I have never seen so well displayed before, and is worth many times over the fancy things got up as "Selected Diatoms" to show the skill of the mounter. There are five species present, which are named. It is interesting to reflect that all these thousands of Synedra and Cocconeis may by gemmation have come from a single individual in each case, united for a time by, and subsequently pushed apart through, the development of a protoplasmic investment. As we survey their countless numbers, we can only liken them to the leaves on a tree. It has been well said that Nature does her greatest works through the agency of the smallest instruments. We have here an apt illustration of it.

Hairs of Viburnum Lantana (Pl. XVI., Fig. 7, Mealy Guelder Rose) make a very interesting slide of a class which is, so far, new to our circulating boxes. Stellate hairs are mostly sessile. In the example before us, however, the stellulæ are evidently seated on low stalks I hope the owner of this slide will pursue the study of "Plant-Hairs" systematically. It is one which, worked out *seriatim*, will yield results both interesting and valuable. I remember noticing with surprise hairs of not less than five well-marked types on the flower of the Snapdragon, *Antirrhinum majus*. A good summary of the subject will be found in the "Micrographic Dictionary," and scattered notes on it in various places in *Science Gossip*.

Caprella linearis (Pl. XVI., Fig. 6) belongs to the Order *Læmodipoda* among the Crustacea. The specimen here is a male. The abdominal leaflets, in the female, form a marsupium or pouch, in which, as with many other Crustaceans, the ova are borne, and to which the young retreat when alarmed till they are able to shift for themselves. Rymer Jones ("Outlines," p. 388, ed. 1861) instances this as one of the most completely annulose forms amongst the Crustacea. In Routledge's "Popular Natural History" (p. 628), the editor, the Rev. J. G. Wood, gives the following very interesting extract from Gosse, after remarking on *Caprella linearis*, or the Mantis shrimp:—"There are several species belonging to this genus, and all possess similar habits. Their bodies are, indeed, skeleton-like in their bony lankness, but

their appetites are by no means small in proportion to their size. Indeed, as is often the case with peculiarly meagre human beings, they are most voracious, preying incessantly on every small creature that comes in their way. They are furnished with terrible instruments of prehension, their first and second pairs of legs being devoted wholly to this purpose. The last joint but one is enormously large, and the last joint is thin, and shuts down like the blade of a clasp-knife into its haft, the groove being represented by a double row of spines, between which the blade is received. The blade itself is finely notched along the edge. These claw-like terminations to the legs are used, not only for seizing prey, but for grasping the branches and drawing the long, attenuated body from one part to another."

Mr. Goss, who has paid much attention to these curious beings, remarks that their movements among the marine vegetation are wonderfully like those of the spider-monkeys among the branches, their long, thin bodies adding to the resemblance. They run about with great agility, and are always to be found among the branches of the *Plumatella cristata.** The same writer has given a very interesting history of the Mantis-Shrimp:— "Their manners are excessively amusing. The middle part of their body is destitute of limbs, having, instead of legs, two pairs of oval, clear vesicles; but the hinder extremity is furnished with three pairs of legs armed with spines, and a terminal hooked blade like that already described. With these hindermost legs the animal takes a firm grasp of the twigs of the polypidom, and rears up into the free water its gaunt skeleton of a body, stretching wide its scythe-like arms, with which it keeps up a see-saw motion, swaying its whole body to and fro. Ever and anon the blade is shut forcibly upon the grooved haft, and woe be to the unfortunate infusorium, or mite, or rotifer, that comes within that grasp. The whole action, the posture, figure of the animal, and the structure of the limbs, are so closely like those of the tropical genus, *Mantis*, among insects, which I have watched thus taking its prey in the Southern United States and the West Indies, that I have no doubt passing animals are caught by the crustacean also in this way, though I have not seen any actually secured.

"The antennæ, too—at least, the inferior pair—are certainly, I should think, accessory weapons of the animal's predatory warfare. They consist of four or five stout joints, each of which is armed on its inferior edge with two rows of long, stiff, curved spines, set as regularly as the teeth of a comb, the rows divaricat-

* Note by Tuffen West:—"If there be no error in this description, it must apply to a *fresh-water* species, as *Plumatella cristata* is a synonym of *Alcyonella stagnorum*."

ing at a rather wide angle. From the sudden clutching of these organs, I have no doubt that they, too, are for seizing prey, and very effective instruments they must be, for the joints bend down towards each other, and the long rows of spines interlacing must form a secure prison, like a wire cage, out of which the jaws probably take the victim, when the bending-in of the antennæ has delivered it to the mouth.

"But these well-furnished animals are not satisfied with fishing merely at one station. As I have said above, they climb nimbly and eagerly to and fro, insinuating themselves among the branches and dragging themselves hither and thither by the twigs. On a straight surface, as when marching (the motion is too free and rapid to call it *crawling*) along the stem of a zoophyte, the creature proceeds by loops, catching hold with the fore-limbs, and then bringing up the hinder ones close, the intermediate segments of the body forming an arch, exactly as the caterpillars of geometric moths, such as those, for example, that we see on gooseberry bushes do. But the action of the crustacean is much more energetic than that of the caterpillar; indeed, all its motions strike me as full of vigour and energy.

"I have seen the large red species swim, throwing its body into a double curve like the letter S, with the head bent down and the hind limbs turned back, the body being in an upright position. It was a most awkward attempt, and though there was much effort there was little effect."

I have no doubt members would be able to keep these crustaceans in an aquarium, and would find very interesting material for study in watching their life-habits and especially their development. A member at Fareham tells me that specimens appeared occasionally in water drawn by a fresh-water pump—an estuary of the sea, perhaps—a quarter of a mile from the pump, but evidently having underground communication with the basin whence the soft water came. I have found *C. linearis* abundantly in tidal pools at Ryde, Isle of Wight.

Hæmatopinus suis.—This specimen appears to have been prepared by simply soaking for a time in turpentine and then mounting in balsam. This plan was recommended long ago by Cornelius Varley in the *London Physiological Journal*, Vol. I., 1841, p. 31. By adopting it, important details of internal structure, destroyed by the plans most in vogue now, of steeping in *liquor potassæ*, may be beautifully retained. I allude in the present instance to the supra- and sub- œsophagal ganglia and nerves proceeding thence to the eyes, the antennæ, and the oral organs. The female differs little outwardly from the male, except for the cleft vulva.

[WE much regret that we are unable to complete Mr. Tuffen West's valuable Notes in the present issue. The remainder, with the "Selected Notes from Note-Books" having reference thereto, with the explanation of Plates XVI., XVII., and XVIII., will be given in our next.—*Editor.*]

Correspondence.

[*The Editor does not hold himself responsible for the opinions or statements of his correspondents.*]

SIR,—

In the *Journal of Microscopy, etc.*, for April, Mr. Wheatcroft draws special attention to the fact that in studying the plant-remains found in Egyptians tombs, Dr. Schweinforth has not been "able to detect any peculiarities in the living plants which are absent in those obtained from the tombs." Mr. Wheatcroft says these specimens were gathered at least four thousand years ago, and he thinks it "would be difficult to produce better evidence of permanency of type." Precisely this argument was used with reference to the theory of permanency of type in animals. We were told that the domestic cat, whether in the mummical state or in its pictured representations, was just the same in that remote Egyptian age as it is at the present day. But we know now that instead of finding permanency of type as the prevailing law amongst animals, we find species and orders fading into one another like dissolving views as we penetrate further back into the abyss of time. The changes are very gradual; to lose a tooth would be far too sudden a transition. One cusp disappears, and then another; then the tooth appears later, grows smaller, decays early, and finally disappears altogether. The same gradual changes occur in the modifications of the whole skeleton, but most noticeably in the limbs. The cat, so "exactly like" our cat of the present day, changes by almost imperceptible degrees into an animal which is neither cat nor weasel, but the progenitor of both; the dog into an animal which is neither bear nor dog, but which has some characteristics of the two modern species.

It is difficult to imagine how any paleontologist of the present day could expect that an animal would be likely to change perceptibly in such a brief second of geological time as four thousand years. The whole of the Tertiary period can only be

expressed as a fraction when compared with the vast ages which must have elapsed whilst the paleozoic and the mesozoic rocks were laid down; and the post-tertiary, when man (as we know him) and the modern species of animals took their rise, is a mere insignificant sediment compared even to the tertiary period. How, then, shall we express the geological insignificance of the human historical period?

Under domestication, it is true that the progress of evolution is more rapid than under normal circumstances. Yet man, so far as I am aware, has only succeeded in accelerating the evolution of one new family, that of the domestic dog, which can be traced through distinct lines of descent from the wolf and jackal. But the domestic dog becomes a true dog long before the oldest Egyptian mummy received its wrappings; the cat, a far more modern and highly specialized carnivore, has not had time to change since it was first domesticated.

What has all this to do with plants? may fairly be asked. I do not pretend to any acquaintance with paleobotany, but I cannot help thinking that the laws which govern one great branch of living beings govern also the other, and that as animals vary by slow degrees during the vast ages of geological time, so plants must also change. We see cultivated plants alter just as rapidly under the hand of man, as domesticated animals; we see the forest tree of warm regions become the creeping shrub of Arctic climes; therefore, we know that vegetable forms vary with the action of their environment as do animals. There is also the same tendency to the late evolution of higher forms which we see in animals, and a tendency in some of the lower forms to dwindle away; as witness the giant calamites of the coal forests, as compared with the pigmy horsetails of the present day. The Equiseta are to the calamites much what the modern newt is as compared with the ancient labyrinthodont. My contention is not as to any point of paleobotany, of which I am certainly not qualified to judge, but only as to the utter insufficiency of the time which has elapsed since Egypt was a civilised kingdom, to produce new species of either animals or plants.

Should anyone wish to see how almost imperceptibly, but how surely, Nature works in altering "types," I would refer him to some of the later lectures of Professor Cope, in his "Origin of the Fittest." A more popular account is given by Oscar Schmidt in "The Mammalia" International Scientific Series.

Yours faithfully,

ALICE BODINGTON.

Vancouver.

Reviews.

Journal of Morphology. Edited by C. O. Whitman, with the co-operation of Edward Phelps Allis, jun. No. 2; pp. 193. (London: W. P. Collins, Great Portland Street. Boston, U.S.A.: Ginn and Co.)

The second part (completing Vol. I.), 419 pp., is just to hand. It contains five valuable papers, which treat of the Kinetic Phenomena of the Egg during Maturation and Fecundation (Oökinesis), by the editor, C. O. Whitman; The Embryology of Petromyzon, by Dr. W. B. Scott, of Princeton College, N.J.; a contribution to the Embryology of the Lizard, by Dr. Henry Orr, of Princeton, N.J.; The Fœtal Membranes of the Marsupials, by Dr. H. F. Osborn, of Princeton, N.J.; and Some Observations on the Mental Powers of Spiders, by George W. and Elizabeth G. Peckham, of Milwaukee, Wis. There are 7 double and 3 single plates. Prof. C. O. Whitman has been for many years editor of the microscopical section of the *American Naturalist*. We feel that we cannot say too much in praise of this work.

The Origin of Floral Structures through Insect and other Agencies. By the Rev. George Henslow, M.A., F.L.S., F.G.S., etc. Crown 8vo, pp. xix.—349. (London: Kegan, Paul, Trench, and Co.) Price 5s.

This is the sixty-fourth volume of the International Scientific Series. The author thinks we must look to the environment as furnishing the influences which induce plants to vary in response to them. His object has been to endeavour to refer every part of the structures of flowers to some one or more definite causes arising from the environment taken in its widest sense. The book contains eighty-eight illustrations.

Nature's Fairyland; or, Rambles by Woodland, Meadow, Stream, and Shore. By H. W. S. Worsley-Benison, F.L.S., etc. Crown 8vo, pp. viii.—232. (London: Elliott Stock. 1888.) Price 5s.

We have read few books which have afforded us greater pleasure than the volume now before us. That Mr. Worsley-Benison is a thorough and "all-round" naturalist is plainly shown in the twenty-one chapters of which the book is composed. These treat of widely different subjects. For instance, we find four or five chapters on Botanical subjects, two or three on Spiders, others on Waves, Rambles on the Dorset Coast, Fishes, The House-Fly's Story told by herself, etc. We would strongly urge any young person about to commence the study of botany to read carefully the three chapters entitled "From Root to Flower," "Out among the Gorse," and "Companions of the Corn." These chapters give, in a peculiarly interesting manner, some important facts in plant anatomy, told in a style which will engrave itself on the mind of the student. All lovers of Nature will do well to read this book. Its subjects are well varied and most interesting.

Forms of Animal Life: A Manual of Comparative Anatomy, with descriptions of Selected Types. By the late George Rolleston, D.M., F.R.S. Second edition, revised and enlarged by W. Hatchett Jackson, M.A. Royal 8vo, pp. xxxii.—937. (Oxford: Clarendon Press. London: Henry Frowde. 1888.)

This edition was taken in hand by the late Prof. Rolleston in the Long Vacation of 1879, and was carried on by him until he left England in Dec., 1880, by which time he had completed the descriptions of Preparations 1—9, and 3 new plates had been engraved under his direction. The distinctive character of this book, as described in the preface to the first edition, consists in

its attempting so to combine the concrete facts of Zootomy with the outlines of systematic classification as to enable the student to put them for himself into their natural relations of foundation and superstructure. The foundation may be made wider, and the superstructure may have its outline not only filled up, but even considerably altered by subsequent and more extensive labours; but the mutual relations of the one as foundation and of the other as superstructure, which this book particularly aims at illustrating, must always remain the same. There are 14 excellently engraved plates.

THE ELEMENTS OF BOTANY for Beginners and for Schools. By Asa Gray. 8vo, pp. 226. (New York and Chicago: Ivison, Blakeman, and Co. 1887.)

This work of the late well-known author is intended to ground beginners in Structural Botany and the principles of Vegetable life, mainly as concerns Flowering or Phanerogamous plants, and to be a companion and interpreter to the Manuals and Floras by which the student threads his way to a clear knowledge of the surrounding vegetable creation. We have the greatest confidence in recommending this book. The last thirty-four pages are occupied by a valuable glossary.

A HISTORY OF PHOTOGRAPHY, written as a Practical Guide and an Introduction to its Latest Developments. By W. Jerome Harrison, F.G.S.; with an Appendix by Dr. Maddox on the Discovery of the Gelatino-Bromide Process. 8vo, pp. 144. (Bradford: Percy Lund and Co. London: Trübner and Co. 1888.)

The volume before us gives, as its title implies, a consecutive account of the principal processes which have been employed in photography during the brief half-century of its practical existence. In its 27 chapters we have an account of the Origin of Photography, Some of its Pioneers, The Daguerreotype, The Callotype, and Collodion Processes, etc. The work is further illustrated with 12 photo-mechanical plates, portraits of some of the fathers of photography. Short biographies of some are also given.

PHOTO-ENGRAVING, Photo-Etching, and Photo-Lithography, in Line and Half-Tone; also, Collotype and Heliotype. By W. T. Wilkinson, of London. Revised and enlarged by Edward L. Wilson. American (third) edition. Crown 4to, pp. xvi.—184. (New York: Edward L. Wilson. 1888.)

In this handsomely got-up volume the author has made many additions to his last English edition. Mr. Wilson has added further to the value of the work by "boiling down" and incorporating the best points from current publications in France and Germany. Chapters and parts from the *Handbuch der Chemigraphie und Photochemigraphie*, by Mr. J. O. Mörch, have also been added, making the work complete up to date.

The volume is divided into six parts, viz.—Photo-Engraving in Line, in Half-Tone, and on Copper; Photo-Lithography in Line and in Half-Tone; and Collographic Printing.

FAMILIAR ANIMALS and their Wild Kindred. By John Monseith, M.A. Crown 8vo, pp. 208. (Cincinnati and New York: Van Antwerp, Bragg, and Co.)

This is a school reading-book (third-reader grade). It conducts the reader by a natural link of association from the more familiar to the less familiar facts about animals. The publishers have evidently spared no expense in presenting a large number of accurate pictures of the more prominent subjects of the text.

An Easy Guide to Scripture Animals, being a Description of all the Animals mentioned in the Bible. By Vernon S. Morwood. Crown 8vo, pp. 184. (London: John Hogg.) Price 1s. 6d.

The animals are described in alphabetical order. After the description will be found a series of questions which will assist the memory, Bible references, and an anecdote. There are thirty fairly good illustrations and a vocabulary explanatory of words used in the book. The book is designed and very suitable for school and home use.

Sunlight. By the author of "The Interior of the Earth." Second edition, with alterations and additions. Crown 8vo, pp. xii.—180. (London: Trübner and Co. 1887.)

Perhaps we cannot better describe this clever little work than by quoting the concluding words of the author's preface:—"In the confusion now existing there is ample room for the serious consideration of my simple suggestion, that light was the first cause of the creation of the earth, acting on a nebulous mass that held in it gases or material sensitive to, absorptive and retentive of that light."

Mechanics and Experimental Science, as required for the Matriculation Examination of the University of London. By Edward Aveling, D.Sc. Crown 8vo, pp. viii.—263. (London: Chapman and Hall. 1888.) Price 6s.

This is one of the series of Science volumes, which the author is bringing out specially to meet the requirements of students practising for the London Matriculation Examination under the new regulations which have just come into force. The present work treats of mechanics, and a great feature of the book is the very lucid explanations given to each branch of this, to many young students, difficult study. It is divided into three sections, under the titles of Kinematics, Dynamics, and Statics. The chapters on "Acceleration," "Falling Bodies," "Composition and Resolution of Velocities," for example, are so carefully handled, and the specimen questions so fully worked out, that we confidently recommend the book to private students, feeling assured that it will help them. Besides numerous examples, a number of London, Cambridge, and other examination papers are given at the end of the book.

Educational Topics of the Day: Chips from a Teacher's Workshop. By L. R. Klemm, Ph.D. pp. 408. (Boston: Lee and Shepard. 1888.)

Many of the articles in this book have appeared in some of the leading educational journals in America. In them the author gives us his mode of thinking and discussing and his manner of teaching. Those engaged in education will doubtless consider some of these chips worth preserving. The book is divided into ten chapters, among which we find "Some Principles and Methods of Teaching," "The Art of Questioning," etc.

Notes on the Birds of Herefordshire. Contributed by Members of the Woolhope Club. Collected and arranged by the late Henry Graves Bull, M.D., etc. 8vo, pp. xxx.—274. (London: Hamilton, Adams, and Co. Hereford: Jakeman and Carver. 1888.)

These notes are not a formal treatise on the structure and classification of the birds of Herefordshire, but rather familiar reminiscences of homely favourites, notices of their every-day habits, and of the superstitions connected with them, with many amusing anecdotes derived from personal observation. Dr. Bull delighted in tracing out the allusions to birds which may be found in

our literature, especially in the poets, and very numerous quotations of this kind are found in these pages. An excellent photographic portrait of Dr. Bull forms a frontispiece to the vol.

A Catalogue of Canadian Birds, with Notes on the Distribution of the Species. By Montague Chamberlain. Crown 4to, pp. v.—143. (St. John, N.B., Canada: J. & A. McMillan. 1887.)

This catalogue brings together the names of all the birds that have been discovered within the boundaries of the Dominion of Canada, from the Atlantic Ocean to the Pacific, and North to the Arctic; and presents these on the system of nomenclature, and in the sequence now generally adopted by American Ornithologists, and gives the geographical distribution of each species.

Volcanoes and Earthquakes. By Samuel Kneeland, A.M., M.D. Crown 4to, pp. 220. (Boston, U.S.A.: D. Lothrop Company. 1888.)

We have here a popular account of Earthquakes and Volcanoes, their nature, causes, effects, and geographical distribution, from personal observation in the Hawaiian and Philippine Islands, Japan, Iceland, and the Mediterranean Basin, Spain, and the United States.

Being for the most part the author's own observations in the countries described, they of course partake largely of personal adventure, and are exceedingly interesting. The illustrations are from photographs and drawings made on the spot, and the whole work is handsomely got up.

Natural Resources of the United States. By Jacob Harris Patton, M.A., Ph.D., etc. 8vo, pp. xvi.—523. (London: W. Allen and Co., Paternoster Square. New York: D. Apperton and Co. 1888.)

In the interesting volume before us, we have a concise narrative of the natural resources of the United States in all their numerous forms—*e.g.*, Coal, Petroleum, Natural Gas, Iron, Gold, Silver, Mercury, Copper, Lead, Zinc, Tin, Precious Stones, Clays, Building Stone, Graphite, Salt, Mineral or Medicinal Springs, Timbers, Grasses, Fruits, etc. etc. The author says:—"These resources are remarkable for their vastness, but equally striking has been the providential care which provided, under such peculiar circumstances, a Christian people—lovers of liberty, civil and religious—to occupy the goodly land, and by their energy and industry to bring into practical use these varied treasures."

The Pleasures of Life. By Sir John Lubbock, Bart., M.P., F.R.S., D.C.L, LL.D., etc. Ninth edition. 12mo, pp. viii.—198. (London: Macmillan and Co. 1888.) Price 1s. 6d.

A series of interesting and instructive addresses delivered by the author at special gatherings of schools and colleges. They embrace a variety of subjects—The Duty of Happiness, The Happiness of Duty, A Song of Books, The Choice of Books, The Blessing of Friends, The Value of Time, and several others.

Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, comprising lists of the papers read during 1887. 8vo, pp. 256. (London: Charles Griffin and Co. 1888.) Price 7s. 6d.

This is the fifth annual issue of this very useful year-book, and contains in addition to the names of the officers, and lists of the papers read during 1887, before Societies engaged in all departments of research, with the names of their authors, an appendix comprising a list of the leading Scientific Societies throughout the world, occupying some twenty-four pages. The Year-Book is a most valuable publication.

THE FOUNDATION OF DEATH: A Study of the Drink Question. By Axel Gustafson and Zadel Barnes Gustafson. Fifth edition revised, 8vo, pp. xxxi.—566. (London: Hodder and Stoughton. 1888.)

The authors of the book before us have treated the subject in a thoroughly exhaustive manner. The work is divided into thirteen chapters, which treat of Drinking among the Ancients, History of Distillation, Adulteration, The Physiological, Pathological, and Moral Effects of Alcohol, etc. etc.

PRE-GLACIAN MAN and the Aryan Race. By Lorenzo Burge. Crown 8vo, pp. 272. (Boston, U.S.A.: Lee and Shepard. 1887.) Price $1.50.

Perhaps we cannot better describe this book than by quoting its somewhat quaint title more at length:—

"A History of Creation, and of the Birthplace and Wanderings of Man in Central Asia, from B.C. 32,500 to B.C. 8,000, with a history of the Aryan race, commencing B.C. 15,000, their rise and progress, and the promulgation of the first revelation; their spiritual decline, and the destruction of the Nation B.C. 4,705, the inroad of the Turanians, and the scattering of the remnant of the race, B.C. 4,304, as deciphered from a very ancient document. Also, an exposition of the law governing the formation and duration of the great glacial period, and a record of its effects on Man, and on the configuration of the globe; a chapter on the Deluge: its cause, locality, and extent; and an account of the 'Oannes Myth.'"

INTRODUCTION TO PHYSICAL SCIENCE. By A. P. Gage, Ph.D. Post 8vo, pp. viii.—353. (Boston: Ginn and Co. 1888.)

The author tells us it has been his aim to adapt the book to the requirements and facilities of the average high school, and he has endeavoured to bring the subjects within the comprehension of the ordinary pupil, without attempting to "popularise" them by the use of loose and unscientific language.

The work contains upwards of three hundred good illustrations.

AMONG THE CANNIBALS OF NEW GUINEA, being the Story of the New Guinea Mission of the London Missionary Society. By Rev. S. McFarlane, LL.D., F.R.C.S. Post 8vo, pp. 192. (London: London Missionary Society. John Snow and Co. 1888.) Price 5s.

We have here most interesting accounts of the Home of the Cannibals, How we get at them, Exploration and Opening up of the Country, Manners and Customs of the Cannibals, etc. etc. The book is illustrated with a series of original drawings by an artist who has visited the island; it contains also portraits of the author, and of two other pioneers of the New Guinea Mission.

THE WORKS OF HUBERT HOWE BANCROFT: The Native Races of the Pacific States. Vol. I., Wild Tribes. 8vo, pp. xlix.—797. (London: Trübner and Co. San Francisco: The History Publishing Co.)

This volume, which is the first of a long series of historical works, evinces a vast amount of research, no fewer than twelve hundred authors, a list of whose writings are given, having been consulted in writing "The Native Races." In it are given the manners and customs, occupation, food, dress, dwellings, social habits, etc., of all the ruder nations from Alaska to Panama. The first chapter is an ethnological introduction, after which the author describes the physical and mental characteristics of the Native Races of the Pacific States under seven distinct groups:—1, Hyperboreans; 2, Columbians; 3, Californians; 4, New Mexicans; 5, Wild Tribes of Mexico; 6, Wild Tribes of Central America; 7, Civilised Nations of Mexico and Central America. The last are not alluded to in the present volume. Several good maps are given, and the whole work will doubtless prove of great interest.

A Practical Treatise on the Diseases of the Hair and Scalp. By George Thomas Jackson, M.D. 8vo, pp. 356. (New York: E. B. Treat. 1887.) Price $2.45.

This work discusses the various phases pertaining to the care of the scalp and hair, and to the treatment of its diseases, parasitic and non-parasitic. The hygiene of the hair is fully described, and directions given for its care. It is addressed to the Medical profession.

The Twelve Tissue Remedies of Schüssler, comprising the Theory, Therapeutical Application, Materia Medica, and a Complete Repertory of these Remedies. Arranged and compiled by William Boericke, M.D., and Willis A. Dewey, M.D. Royal 8vo, pp. 303. (Philadelphia: F. E. Boericke. 1888.)

We are told that the treatise before us contains all that Schüssler himself wrote on the subject, and embodies as well the whole published experience of the homœopathic school in their use, besides much original matter from homœopathic practitioners published for the first time.

Ambulance Lectures, to which is added a Nursing Lecture in accordance with the St. John Ambulance Association, for Male and Female Classes. By John H. Martin, M.D. Second edition. Post 8vo, pp. xii.—136. (London: J. and A. Churchill. 1888.) Price 2s.

The six lectures of which this little work is composed were delivered to separate classes of both sexes during the winter of 1885—6. The subjects of the different lectures are The Human Body and its Construction, Hæmorrhage, Fractures, Shock or Collapse, Methods of Lifting and Carrying the Sick and Injured, and Nursing. There are 59 illustrations.

First Principles of Modern History. 12mo, pp. 140. Price 1s.

How to Spell and Speak English. 12mo, pp. 32. Price 1s.

A Simple Catechism of the Animal, Vegetable, and Mineral Kingdoms. pp. 72. Price 9d.

English Grammar for Beginners. Part I., The Parts of Speech. By John Hugh Hawley, M.C.P. Post 8vo, pp. 29. Price 6d.

Dates made Easy: A Mnemonic Synopsis of the History of England. By John Hugh Hawley, M.C.P. Post 8vo, pp. 32. Price 6d.

Lesson-Pegs. Second edition. Small 4to. Price 1s.

A Geographical Text-Book for Beginners. By William B. Irvine. Fifth edition. 4to. Price 1s.

(London: Relfe Bros., 6 Charterhouse Buildings.)

Messrs. Relfe Bros. have sent us a small library of useful little books, all well suited for school use. The Modern History treats of Home, Imperial, and Foreign Politics and Social Progress, and impresses on the youthful mind something of the grandeur of the British Empire. How to Spell and Speak English contains a sketch of the History of the Language, and as a frontispiece a Tree representing the Indo-European or Aryan Family of Languages, containing 8 principal branches or groups. The Catechism of the Animal, Vegetable, and Mineral Kingdoms is nicely adapted to the capacities of young children, and has reached its 7th edition. The Geographical Text-Book contains a large amount of useful information, concisely given, and twelve nicely-coloured plates.

MANUAL OF PHARMACY AND PHARMACEUTICAL CHEMISTRY. By Chas. F. Heebner, Ph.G. Crown 8vo, pp. 213. (New York: Published by the Author, 5 Gold Street. 1887.) Price $2.

This work, though intended for the American pharmacist, contains a good deal of information likely to prove serviceable to the English student of pharmacy. Metrology, Specific Gravity, and Volume receive careful notice, and we think the Chemistry and Pharmacy are of high order. The articles on Percolation and the Preparation of Fluid Extracts will also be found useful.

TALKS WITH YOUNG MEN. By J. Thain Davidson, D.D. Crown 8vo, pp. viii.—286. (London: Hodder and Stoughton. 1888.) Price 3s. 6d.

A series of twenty familiar addresses, delivered in one of our London churches to young men at their monthly Sunday evening service. These "Talks" are plain and homely, and each lecture is full of interest.

BRITISH BIRDS and their Nests and Eggs. By W. Harcourt-Bath. With a Chapter on Collecting and Preserving Birds, by R. Bowdler-Sharpe, F.L.S., F.Z.S., etc. Crown 8vo, pp. 112.

SILKWORMS. By Edward A. Butler, B.A., B.Sc. Crown 8vo, pp. 100. (London: Swann Sonnenschein and Co. 1888.) Price 1s. each.

These are two of the useful series of little books known as "The Young Collector Series." In the first of these, Mr. Bath describes a great number of our British Birds; he gives us also a classified list of upwards of 400 British birds, with their scientific as well as common names. Mr. Sharpe gives at the end of the book some valuable hints on collecting and preserving birds.

In the volume on "Silkworms," we have a History of Silk-Culture, with the Life-History of the Silkworm, its Internal Structure, its Rearing and Management, and its Diseases. Both books are nicely illustrated.

HOME EXPERIMENTS IN SCIENCE for Old and Young: A repertory of simple experiments with home-made apparatus. By T. O'Conor Sloane, E.M., A.M., Ph.D., etc. Crown 8vo, pp. 261. (London: Sampson, Low and Co. 1888.) Price 6s.

The object of the author has been to show such experiments as can be performed with home-made apparatus, or without any special apparatus at all. A great number of interesting and instructive experiments are described in a pleaing manner—thus we have Experiments in Mechanics, in Gravitation, Hydraulics and Pneumatics, in Molecular Physics, with Soap Bubbles, and in Heat, Sound, and Light. There is also a chapter on Scientific Lecturing. The illustrations, of which there are nearly 100, are good.

THE READY-REFERENCE DICTIONARY, containing 35,000 words. Edited by W. R. Balch. Crown 8vo, pp. 344. (London: Griffith, Farran, Okeden, and Co. 1888.) Price 3s. 6d.

The chief features about this Dictionary are—1st, the fronts of the pages are cut index fashion, so that the book may always be opened at the required initial letter; 2nd, the common words understood by everybody are, as a rule, omitted; and 3rd, each word is carefully pronounced. The meanings given to the different words-are short and to the purpose.

A very handy dictionary, and convenient for reference.

A HIGHER ARITHMETIC, and Elementary Mensuration for the Senior Classes of Schools and Candidates preparing for Public Examinations.

By P. Goyen. Crown 8vo, pp. xv.—360. (London: Macmillan and Co 1888.) Price 5s.

This book will, we think, prove of immense value to students working without a master, to pupil teachers and senior pupils. No formal rules are given in the arithmetical portion of the book, but the subject is so presented that the student can readily make them for himself. The worked-out examples are considerable in number, and very varied in type, so that the student having worked up these should find no difficulty in solving the exercises. We are much pleased with the style of reasoning employed, and feel that we can confidently recommend the book.

ARITHMETIC FOR BEGINNERS: A School Class-Book of Commercial Arithmetic. By the Rev. J. B. Lock, M.A. 12mo, pp. vi.—200. (London: Macmillan and Co. 1888.)

The problems here given are well varied, and the worked-out examples are well and clearly explained. In writing the book, the author kept carefully in view the requirements of the New Examination for Commercial Certificates. A chapter on Exchange and Foreign Money has been introduced, and some specimen examination papers are added.

A MANUAL OF PHONOGRAPHY. By Isaac Pitman. Five hundred and seventieth thousand. New edition, 12mo, pp. 87. (London and Bath: Isaac Pitman and Sons. 1888.) Price 1s. 6d.

This edition of the "Manual of Phonography" has been entirely re-cast. About six months ago, over one thousand copies were sent out, *in proof*, to expert phonographic teachers and reporters, for suggestions and improvements. Their experience is embodied in the present edition. So great was the desire of phonographers to make this book as perfect as possible, that many of the returned proof copies had to be sent a second and a third time.

After these proofs had been returned, about one hundred more, as final proofs, were examined by different phonographers. The book has been re-set in new type, and increased by twenty-four pages, the price remaining the same, namely, 1s. 6d. The foundation of the book is laid on the lines of the new "Phonographic Teacher," which was received with much approval when issued about twelve months ago.

It is with much pleasure that we recommend this book to the notice of our readers.

WILL-MAKING made Safe and Easy. By Almaric Rumsey, Barrister-at-Law, etc. 12mo, pp. 140. (London: John Hogg. 1888.) Price 1s.

We do not consider it a safe practice for persons to make their own wills, but when they determine to do so, it is well for them to take as good a guide as they can procure. The author hopes that the book before us may be of use—(1) to persons who wish to prepare their own will; (2) to clergymen and other well-educated persons who assist their less erudite neighbours in Will-making; and (3) to members of the legal profession. The instructions are given in plain and homely language,

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THROUGH A MICROSCOPE Something of the Science, together with many curious observations indoor and out, and directions for a Home-made Microscope. By Samuel Wells, Mary Treat, and Frederick Leroy Sargent. 12mo, pp. 126. (Chicago: The Interstate Publishing Co.)

Describes, in simple language, the construction and application of the microscope, and instructions are given for viewing many of the fresh-water organisms.

THE GAME OF DRAUGHTS simplified and illustrated with practical diagrams. By Andrew Anderson. Fifth edition. Revised and extended by Robert M'Cullock, Glasgow. 8vo, pp. xxii.—136. (Glasgow: James P. Forrester. 1887.) Price 1s.

Those who are not skilled players will do well to study this little book. It contains Instructions, Names of the Games and How Formed, Standard Laws, Theory of the Moves, and Series of Elementary Positions, and a large numbers of played-out Games, Problems, and Solutions.

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GUIDE TO THE STUDENT IN BOTANY.

OUTLINE OF THE FIRST-YEAR COURSE IN NATURAL SCIENCE. By Edward S. Burgess.

Two little works intended to supply students in the Washington High School, with outlines for their course of study in Botany and Natural Science. All students will find the outline instructions here given most useful.

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MOFFATT'S GEOGRAPHY OF THE BRITISH EMPIRE.

THE EARTH AND SOLAR SYSTEM.

MOUNTAINS AND RIVERS.

12mo, pp. 89, 103, 78. (London: Moffatt and Paige.) Price 1s. each.

These three little books give a large amount of information in a condensed form.

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A KEY to the Mysteries of Water, Electricity, and Heat. By William Baggatt. Crown 8vo, pp. 70. (London: Trübner and Co. 1888.) Price 1s.

In this little book the author submits to the judgment of Scientists who can divest themselves of their *preconceived opinions*, certain facts respecting the nature and properties of Electricity, which have for some time occupied his thoughts.

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THE GARDENER'S RECEIPT BOOK: a Treasury of Interesting Facts and Practical Information useful in Horticulture. By William Jones. Sixth edition. 12mo, pp. 122. (London: Groombridge and Sons. 1888.) Price 1s.

We are told here the most effectual method for the destruction or removal of everything injurious to the garden; with preventatives and cures for the various diseases of plants, and directions for the preservation of trees, fruits, and flowers.

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SONGS OF A PARISH PRIEST. By Rev. Basil Edwards, M.A. 12mo, pp. xiii.—141. (Orpington, Kent: George Allen. 1888.)

A little volume of poems, of which the author says in his preface—"The quiet of a country charge has enabled the writer to endeavour to link together many of the objects most prominently connected with sacred thought in a rural parish, and to present the results to the reader in somewhat of a sequence, leading step by step from the lych-gate to the altar."

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THE DIVINE PROGRAMME OF THE WORLD'S HISTORY. By Mr. and Mrs. Grattan-Guinness. 8vo, pp. viii.—455. (London: Hodder and Stoughton. 1888.) Price 7s. 6d.

The aim of this volume is apologetic. Its argument is based on the Old Testament canon, "When the word of the prophet shall come to pass, then shall the prophet be known that the Lord hath truly sent him." The subject

is treated in seven sections, which together embrace the whole scope of Bible prophecy from Adam to Christ, the object of the writer in each division being to show that predictions, *à priori*, the most improbable have literally and invariably been fulfilled in the way indicated, and hence the conclusion that the original word was *inspired*. Devout readers will find much in this work to refresh their minds and strengthen their faith.

ILLUSTRATIONS: A Pictorial Review of Knowledge. Conducted by Francis George Heath. Crown 4to. Nos. 1—8. 1887—8.

It is needless to say that illustrations form a somewhat prominent feature of this magazine; they form, however, by no means the all-important part of it. The articles are numerous, carefully written, and well varied. Perhaps the contents of the last number will fairly represent the whole. These are:—A Study of May; Michael Dickson's Wife, a Prize Story; Those Young People, a Serial Story; Cycling; Through the Opera Glass; Prize Drawing Competition; Pen-and-Pencil Portraits; Home; Garden, Field, and Farm; Schools, Private and Public; Inventions; Funny Old Customs: May Day; The Great Auk. Each article is profusely illustrated.

GALL AND INGLIS'S SCHOOL ATLAS of Modern and Ancient Geography. Imperial 4to. (London and Edinburgh: Gall and Inglis.)

This atlas contains thirty-three very distinctly-engraved maps, all of which are nicely coloured. These maps are 14 in. by 11½ in., except one, which is double that size. This atlas will be found exceedingly useful in schools.

FIRST STEPS TO SCIENTIFIC KNOWLEDGE, complete in Seven Parts. By Paul Bert. Translated by Madame Paul Bert. Revised and edited by Wm. H. Greene, M.D. Post 8vo, pp. 374. (Philadelphia: J. B. Lippincott and Co.)

This book has already enjoyed a very large circulation in France and in our own country, and we make no doubt that it will also do so in America. We know of no book covering so wide a field of scientific knowledge, all of which is brought down to the capacity of children. It treats of Animals, Plants, Stones, and Rocks; Physics; Chemistry; and Animal and Vegetable Physiology.

THE EDUCATION OF MAN. By Friedrich Froebel. Translated from the German and annotated by W. N. Hailmann, A.M. Crown 8vo, pp. xxv.—332. (New York: D. Appleton and Co. 1887.)

This is the fifth volume of the International Educational Series, and is a faithful rendering of Froebel's important work, which, as Dr. Harris says in his editorial preface, deserves a thorough annual study by every teacher's reading-club in the land. The translator's explanatory notes contribute very materially to the right understanding of some difficult passages. The work is divided into two parts. The first deals with general principles, and considers the development of man during infancy and boyhood. The second discusses the chief subjects of instruction, grouping them under (1) religion, (2) natural science and mathematics, (3) language, (4) art.

THE LAWS OF EVERY-DAY LIFE, for the Use of Schools. By H. O. Arnold-Forster. Crown 8vo, pp. 240. (London: Cassell and Co.) Price 1s. 6d.

This book, which contains many useful lessons, is intended for school use, and is designed as an introduction to the study of elementary political science. It is divided into four parts:—The Law of the Land, the Laws of Nature and Reason, How to Live under the Law, and Work and Workers. It is written in language suitable for young people.

1,000 Ways of Earning a Living. 12mo, pp. viii.—184. (London: *Tit-Bits* Office and Carr and Co.) Price 1s.

A large amount of time and pains has been spent on the production of this book. It treats of Employment for Girls, Youths, The Educated of both sexes, The Middle-Aged of both sexes, Useful Hints and Suggestions to all seeking Occupation, or Emigration.

The paragraphs are arranged in alphabetical order under their various titles, commencing with *Actors* and concluding with *Wood-Carving* and *Young Women's Help Societies.* Persons driven by force of circumstances to seek employment will do well to consult this book.

Birds'-Nesting and Bird-Skinning: A Complete Description of the Nests and Eggs of Birds which Breed in Britain. By Edward Newman. Second edition. Revised and re-written, with directions for their Collection and Preservation, and a chapter on Bird-Skinning by Miller Christy. 12mo, pp. xii.—138. (London: T. Fisher Unwin. 1888.)

In this little book a careful description is given of the nests and eggs of all the British birds. The eggs are very accurately described—usual number in a clutch, maximum and minimum measurements of eggs to decimals of an inch, colouring, and other particulars. Instructions in birds'-nesting with tools and accessories necessary, and in bird-skinning, are also given. This is a very useful little book.

Natural Causation: An Essay, in Four Parts. By C. E. Plumptre. 8vo, pp. 198. (London: T. Fisher Unwin. 1888.) Price 7s. 6d.

Under the title, "Natural Causation," we have grouped together the following essays, viz.—The Doctrine of Design, viewed from the Standpoint of Evolution; Philosophical Necessity, a Defence; Natural Growth in Ethics; and Natural Growth in Civilisation. In these essays the author sets himself to prove that everything in our world has proceeded by natural laws and not by arbitrary interference, but rather in spite of it. These essays are thoughtfully written. At the end of the book is a lengthy index, which will prove of value in referring to any special argument.

Natural Philosophy for Beginners.—We regret to notice that in our review of this little book, p. 128, our compositor has made us use the words "pinetics" and "pinematical" for "kinetics" and "kinematical," and "Veetors" for "Vectors."

Elementary Lessons in Astronomy. By J. Norman Lockyer, F.R.S. 12mo, pp. xvi.—363. (London: Macmillan and Co. 1888.) Price 5s. 6d.

This, although not so stated on the title-page, is a revised edition of Mr. Norman Lockyer's "Elementary Lessons in Astronomy," and in the earlier portions of the book references are made to the conclusions, having reference to the heavenly bodies that the author has recently communicated to the Royal Society.

The work is illustrated with sixteen fine steel plates, which have been placed at the author's disposal by Mr. Warren de la Rue; there are besides nearly 100 smaller engravings.

The Mystery of the Ages, contained in the Secret Doctrine of all Religions. Second edition. By Marie, Countess of Caithness, Duchess de Pomár. 8vo, pp. xxxii.—541. (London: C. L. H. Wallace, Oxford Mansions. 1887.)

We have not seen this work before; but from the appearance of the text we suppose it was formerly published under the title of UNIVERSAL THEOSOPHY, a title which will sufficiently explain the nature of the work.

OUR ENGLISH SHORES, being Recollections of Watering-Places on the Coasts of England. By William Miller, F.R.S.E. Crown 8vo, pp. xvi.—234. (Edinburgh: Oliphant, Anderson, and Co. London: Hamilton, Adams, and Co. 1888.) Price 6s.

This book, unlike a "Guide-Book," which generally gives stereotyped descriptions of the various seaside resorts, consists of a congeries of little tours, and recounts the results of visits paid by the author to seaside towns on the coast of England. These sketches will be found to be most readable and interesting. The illustrations are nearly all selected from the author's sketches, and are reductions by photo-zincography from pen-and-ink copies.

A TREATISE ON PLANE TRIGONOMETRY, containing an account of Hyperbolic Functions, with Numerous Examples. By John Casey, LL.D., F.R.S. Crown 8vo, pp. xvi.—271. (Dublin: Hodges, Figgis, and Co. London: Longman, Green, and Co. 1888.) Price 7s. 6d.

This work contains not only everything that is usually given in books on trigonometry, but also much that has hitherto appeared only in mathematical periodicals. Its eight chapters treat of—First Notions on Trigonometric Functions; Trignometric Formulæ; Theory of Logarithms; Trigonometric Tables; Formulæ relative to Triangles; Resolution of Triangles and Quadrilaterals; Continuation of the Theory of Circular Functions; and Imaginary Angles.

IN TOUCH WITH NATURE: Tales and Sketches from the Life. By Gordon Staples, C.M., M.D., R.N., etc. Crown 8vo, pp. 224. (London: Society for Promoting Christian Knowledge. 1888.) Price 2s.

Nineteen most interesting chapters compose the book before us, concerning which the author tells us that the stories and the sketches were all born out of doors, in his orchard wigwam, in his woodland study, in ships in Arctic seas, and in the Tropics during his caravan wanderings for the past three years. The book is nicely illustrated.

THE ART OF PREPARING VEGETABLES for the Tables. By Sutton and Sons, Reading. 12mo, pp. 68. (London: Hamilton, Adams, and Co. 1888.) Price 1s.

Messrs. Sutton and Sons give us here what they describe in their introduction as an "elementary code of vegetable cookery that the cooks themselves may not disdain, and that many who are not cooks, but desire to know something of the art of cookery, may give attention to as of direct, practical value to them." Our lady friends to whom we have submitted this little book speak of it in high praise.

AN EXAMINATION OF THE THEORY OF EVOLUTION and some of its Implications. By George Gresswell. 8vo, pp. xiv.—155. (London: Williams and Norgate. 1888.) Price 1s.

The work before us is evidently the outcome of much serious thought. It appears to have grown out of a lecture entitled "The Evolution Hypothesis," published at Cape Town in 1885, to which many new ideas have been incorporated. The book is divided into 11 chapters.

SAND-BLAST CELLS.—Referring to a note on this subject, which appeared on p. 50 of the *Journal of Microscopy* (January), Mr. B. Pifford, of Hemel Hampstead, Herts, sends us specimens of his Countersunk Cells.

The Air Bladder of Fishes considered as a Degenerate Lung.

BY MRS. ALICE BODINGTON.

AS the result of numerous investigations as to the condition of the air-bladder of fishes, Mr. Charles Morris, of the Academy of Natural Sciences of Philadelphia, has arrived at the conclusion that this organ was not primarily evolved as an aid in swimming, but was originally a lung.

As with most degenerating organs, the air-bladder is found in all stages of arrested development. In the most highly-specialised fish, the Teleosteans, it exhibits an extraordinary variation in shape, size, and relation to the body. With some Teleosteans the air-bladder has an open pneumatic duct connecting with the œsophagus, and in a few cases with the stomach. With others this duct exists, but its cavity is closed. In some cases it is reduced to a fine ligament. In many other Teleosteans no traces of it exist. *These variations have no appreciable effect upon the velocity and activity of the fish.* Those that have no air-bladder seem in no respect at a disadvantage as compared with those that have one. These variations remind one of the various stages of degeneration of the eye and optic nerves in blind animals.

If the air-bladder is of absolute necessity to a fish as a gravitating organ, why is it not necessary to all, and why has it not developed into some shape and condition of greatest efficiency? No animal organ, whose function is of known importance, presents such extraordinary modifications. In the heart, lungs, brain, etc., there is one shape, position, and condition of greatest efficiency, and throughout the lower forms we find a steady advance towards this condition. There is in all these organs a persistent movement towards homogeneity—not towards heterogeneity, such as we find in the air-bladder. The existence of the air-bladder is proof that it has had, at some time, a function of considerable importance. Its many variations go to prove that it has ceased to perform any

essential function, and is on the road towards extinction. On no other theory can we explain its great diversity in nearly-related species.

If, then, we may look upon the air-bladder as an organ which has partly or wholly lost its original function, the question follows, What was that function? There are certain good reasons for believing that *the breathing of air was the original purpose of this organ.* In mature Teleosteans this is occasionally indicated by the existence of a pneumatic duct connecting with the œsophagus. This duct is usually of no functional use, and varies from partial to complete disappearance. *But all fishes with an air-bladder possess a duct in the early stage of embryological development.* In the mature stage it is lost by all Teleosteans except the Physostomes. The extraordinary development of *retia mirabilia* in the inner tunic of many air-bladders, though now used only for the secretion of gases, may be survivals of ancient pulmonary capillaries, which have changed their character with their function. And the apparatus for compressing and dilating the bladder may have been originally developed purely for respiratory purposes, as this embryological persistence of the pneumatic duct would lead one to suppose.

From the evidence afforded by embryology, we proceed to that given by paleontology. The ancestors of the modern Teleosteans, the Ganoids, all possess an air-bladder, which remains a fully-developed air-duct in the mature stage. In the sub-order, DIPNOI, the air-bladder is functionally developed as a lung, and as counterparts of these fishes existed in the Devonian age, it is probable that they breathed air then as they do now.

In the higher animals the duct connects with the ventral side of the œsophagus, whereas in most of the Ganoids the air-duct opens into the dorsal side of the œsophagus. But Wilder shows there is a series of forms, mostly Ganoids, leading from Amia and Lepidosteus, with the air-duct entering the throat or the dorsal side, to Lepidosirea, in which it enters on the ventral side, as in the higher vertebrates. In all the fishes just named, the air-bladder functions as a lung; in Polypteros it has lateral divisions; in Lepidosteus, the American Gar-Pike, it is cellular and lung-like. The fish keeps near the surface, and may be seen to emit

air-bubbles. The American Bow-Fin or Mad Fish (Amia) has a bladder of the same lung-like character, and has been seen by Wilder to come to the surface, open its jaws widely, and apparently swallow a large quantity of air. Wilder remarks that, "so far as experiments go, it seems probable that with both Amia and Lepidosteus, there occurs an inhalation and exhalation of air at pretty regular intervals, the whole process resembling that of Menobranchas and other salamanders."

The Dipnoi have the air-bladder developed into a true lung. Of these the Australian lung-fish, Ceratodus, has but a single air-bladder, but this is provided with breathing pouches, which have a symmetrical-lateral arrangement. It has no pulmonary artery, but receives branches from the *Arteria cœliaca*. Finally, Lepidosteus and Protopterus have completely-formed lungs, divided into two lateral chambers, and provided with a pulmonary artery. Their cellular structure nearly approaches that of the batrachian lung.

Professor Günther says that some "fishes breathing air are, even when brought into pure water, obliged to rise to the surface at frequent intervals to take in a quantity of air, and, if kept beneath the surface by means of a gauze net, they perish by suffocation." In carrying out researches as to the original condition of any organ, we find it always necessary to begin with low forms. For instance, in studying the history of mammalian dentition, we do not take the cats, whether recent or extinct, as guides; we study the dentition of the early Eocene mammals, and even peer back into deeper recesses of time to examine the teeth of Jurassic mammals. And the same rule applies to researches as to the development of the brains and limbs of animals. We go as far back and as low down as possible. Therefore, we are only following sound, scientific precedents, if, when wishing to understand the original function of the air-bladder, we study this organ, not amongst the highly-developed Teleosteans, but amongst the survivals of archaic forms. If in fishes whose prototypes are found in the Devonian age, the air-bladder functions as a lung, we have good reasons for assuming that this was the original function of the organ. To study the air-bladder as it exists in Teleosteans would be like studying the development of the fingers in horses

or the development of the hind limbs in whales. We should not discover the original history of these organs, but only that of their extreme modification, or gradual suppression.

Mr. Morris next asks us to imagine what were the conditions of life under which this organ was developed, and what were the later conditions which rendered it in great measure or entirely useless. The question takes us back to Devonian and Silurian geological periods. In this era the seas were thronged with fishes of two distinct orders—the Elasmobranchs and the Ganoids, the former without, the latter with, an air-bladder. This difference in organisation was probably the result of some marked difference in their life-habits. The Ganoids may have inhabited poorly aërated waters, or waters otherwise ill-adapted to breathing, while the Elasmobranchs may have had their primordial habitat in clearer and purer waters.

But there were other conditions which may have been the main influencing causes of the development of an air-breathing organ. We know that the land was habitable for long ages ere it gained any vertebrate inhabitants. The presence of insects in Devonian and Silurian strata proves this. Long ages passed during which we have no evidence of land animals higher than insects or snails, and the earth must have possessed much food material, both vegetable and animal, available for a larger population than it possessed. It is hardly probable that the active fish of the early seas made no effort to obtain a share of this food. As many fishes now leave the water temporarily for the land, in search of food, notwithstanding the many dangerous enemies which lie in wait for them, it is only reasonable to suppose that many fishes may have done so in remote ages, when no such redoubtable foes awaited them. Such fishes as left the sea for the land would find their enterprise richly repaid by ample food, and would therefore have had a powerful inducement to continue the habit. Other influences may be inferred to have been at work then, as they are now. Foul and muddy water, and the drying-up of pools, which now cause fish to breath atmospheric air, must have been causes as likely to be active in Devonian times as now.

At the opening of the carboniferous era there may have been many lung-and-gill breathing Dipnoi, finned Batrachians as we

may call them, which spent much of their life on shore. And their habits of land life would naturally be attended by a gradual change of the fins into better walking organs, from which by a long continued process of evolution, may have arisen the leg and foot of the primordial batrachian. For this purpose, to become fully developed, however, the development of an internal bony skeleton was necessary, and with the completion of this step of evolution the lung-breathing fish probably directly unfolded into the true amphibian. Were we left to imagine what such a fish would be like, could we draw any form which would differ much from the existing Perennibranchiates?

But with the existence on land of vertebrates with bony skeletons, the dominion of the fish must have gradually decreased. The formidable reptiles which for a time had the mastery of the world, would make *terra firma* less and less of a desirable resort. The fin, too, could not compete with the leg and foot as an organ of land motion, and those Dipnoi which had remained mainly fish-like were probably driven back to the water. As a result of this change of conditions, a retrogressive change took place in the air-breathing organ. Some fishes never cease to use it as a lung, as modern Dipnoi. Yet, with the Ganoids, as a rule, it has been used only temporarily for breathing purposes. But with their successors, the Teleosteans, it has lost all air-breathing capabilities, and has passed through every stage of degeneration, from a condition closely resembling that of the Ganoids to complete extinction. This theory is not vitiated by the fact that the organ has developed secondary uses. Innumerable instances exist of secondary adaptations of organs which embryology shows had once far different uses, as in the transformations which the gill arches have undergone in the higher vertebrates, and the still more extraordinary modifications of functions in the primitive kidneys. One remarkable fact may be mentioned as showing that the air-bladder has an important function in the aëration of the blood in deep-sea fishes. In fresh-water forms the organ contains nearly pure nitrogen, whilst in deep-swimming sea-fish oxygen forms its main contents (Dr. Günther states that the proportion is sometimes as high as 87 per cent. of oxygen). This difference is not due to any differences in the gases contained in water at various depths, for

the percentage of nitrogen is closely the same at all depths, while oxygen diminishes in quantity from the surface downwards. Thus, if the contents of the air-bladder depended on the relative quantity of gases present, nitrogen should predominate below as well as above. Furthermore, as showing that the bladder still functions as an aërating organ, Cuvier says that when a fish is deprived of its swim-bladder, the product of carbonic acid by the branchiæ is trifling. We cannot imagine such a result unless the air-bladder in some way supplies oxygen to the blood, and thus continues to perform, in an indirect manner, its probable original function of a breathing organ.

If the hypothesis offered be a well-founded one, an interesting conclusion as to the process of organic evolution may be taken. We should see the air-breathing function at first performed by the unchanged walls of the œsophagus. Then this became pouched. Then the pouch became constricted off, with a duct of connection. Then, as the original function vanished, the duct disappeared, and what was originally a portion of the wall of the intestinal canal became a separate internal sac. Then this sac in many instances decreased in size, until in some cases it became a closed internal bladder of the size of a pea, far removed from and utterly disconnected with its place of origin. Finally, it completely vanished. This process, if correctly drawn, certainly forms a very remarkable cycle of development and degeneration, which probably has no counterpart (Mr. Morris thinks) of a similarly striking character in the whole circle of organic life.

Finally, it may be remarked that though many fish use their air-bladder in all probability for gravitative purposes, yet, as many most active fishes have no air-bladder, this organ could not by any known law of evolution have been elaborated for a purpose which actively-swimming fish can so easily dispense with.

I will only say, in conclusion, that this paper consists of such copious extracts from Mr. Morris, that I have thought it unnecessary to use inverted commas when quoting from his article. Had I done so, my paper would have been, as the old lady found "Macbeth," too "full of quotations."

Development of the Tadpole.

By J. W. Gatehouse, F.I.C.

Part IV.

Plates XIX., XX., XXI.

TRACING back the development of the claspers described on p. 151 (July), we find that, like the rest of the organs, they too have undergone most decided alterations both in form and structure, appearing first as a mere thickening of the epiblast, as seen in Fig. 1, Plate VII., and Figs. 1 and 2, Plate VIII. We next find them showing an apparent invagination, or rather perhaps a ring of dark, elongated, epiblastic cells, converging towards a central opening, and resting upon what appears to be a modification of cartilage. The whole is bounded posteriorly, that is, on the inner side, with a single layer of cells continuous with the mesoblastic layer, and indeed forming an integral part of it (Fig. 5, Plate XXI.). A section made two days later shows the appearance given in Fig. 3, the two points shown in Fig. 4 having advanced outwards and become double, whilst the structure as a whole has also suffered a more complete longitudinal division. The growth of this organ, as a whole, is therefore seen to proceed much on the same lines as that which occurs in simple cell division. These points ultimately coalesce, the central division remaining, so that in their most perfect development we arrive at the structure already figured in Plate XIII., Fig. 7.

In our last article some doubts were thrown out as to the true function of this organ, and when we consider its epiblastic origin, and also that muscles are produced from the mesoblast, we are compelled to arrive at the conclusion that these so-called claspers do not clasp, and also that they are not suctorial discs, for not being muscular they cannot suck, and are therefore not homologous with the suctorial mouth of the Cyclostomata, as seen in the Lamprey. What, then, is this structure? What are its functions? We have seen that at one period of its history it certainly appears to partially support the animal in the water, but

having regard to its minute structure, which bears no indistinct resemblance to the brain at an early stage, as well as to its epiblastic origin, we are forced to the conclusion that its real function is to act as a special sense organ, enabling the animal, before it possesses eyes or ears, to place itself by feeling in communication with that small portion of the outer world which forms its limited surroundings. When more specialised organs are produced, these primitive ones atrophy, as they are of no further use.

As, up to the period to which we have arrived, one of the most prominent structures seen in all the sections has been the notochord, we will trace its history in some detail. In Plate XIX., Fig. 2, of the present number, will be found a diagram of the anterior end of this structure, as it existed in an animal of March 20, enlarged 100 diameters; but more or less complete indications of it may be found in all the previous plates, with the exception of the first. Reference should be made to these, and especially to Figs. 7 and 8, Plate II., of January, 1888, and also to Plate XIII., of the July part, for various longitudinal sections.

Our previous observations led us to the conclusion that the whole of the organs of the animal were produced from either the epiblastic, hypoblastic, or mesoblastic layers. In *Amphioxus*, the Ascidians, the Lamprey, and *Lepidosteus*, it has been demonstrated by several observers that the notochord is derived from the hypoblastic layer. Towards the anterior portion of the embryo—that is, the portion which ultimately forms the head—certain of the hypoblastic cells split into two, so that whereas the hypoblast is formed of a single layer of cells in the greater portion of the embryo, yet at this particular point it consists of two layers, the under one of which becomes the notochord. This double layer of hypoblastic cells extends from the front to the hinder end of the embryo in an axial line, nearer to what will ultimately be the dorsal than the ventral side. The distinct formation of the lower layer of cells into the notochord occurs first towards the front, and gradually extends towards the back. Götte has thrown grave doubts as to whether this is the mode of formation of the notochord in the case of the frog and other Anura. He states that the notochord is formed, not from the hypoblast at all, but from the mesoblast. His statement,

illustrated by sectional diagrams, is, that the mesoblast forms a continuous sheet around the ovum, under the epiblast, and that in the axial dorsal line a central chord becomes separated to form the notochord. Calberta, however, states, that when the mesoblast is fully formed, and separated from the hypoblast, it does not form a continuous sheet, but that it is broken in the dorsal axial line, and the two portions separated from each other by a ridge of hypoblastic cells. It is this hypoblastic ridge, he says, and not a layer of cells from the mesoblast, which becomes differentiated into the notochord.

Balfour says that his own observations are in favour of the latter statement, as the mesoblast never appears to form an absolutely continuous sheet. When such eminent embryologists differ, it would be the highest presumption on my part, with my very limited number of sections, to offer a decided opinion on so extremely delicate a matter; but I may state that when cutting my earlier sections many of them were rejected because the layer of mesoblast was never found perfect, and as my time for mounting is very limited, I was obliged to retain only those which, from the observations of previous observers, were considered most nearly accurate. As, however, in other types there appears to be no doubt that the notochord is really derived from the hypoblast, it is very probable that the same thing takes place in this. As no invertebrate animal possesses a notochord, it will be seen that the study of this structure is of the highest importance in an embryological sense.

It would appear, from the observations of Götte, Schneider, Balfour, and others, that the structure of the notochord in the TELEOSTEI, ELASMOBRANCHII, etc., is distinctly different from that of the Amphibians, the former possessing an elastic sheath, called the membrana elastica externa, and the latter being devoid of this structure. My own sections, at the date given, and as roughly drawn in Pl. XIX., Fig. 2, show that the notochord at this period consists of three parts:—Firstly, a central cellular portion; secondly, a delicate layer of cells; thirdly, a strong, fibrous, elastic sheath. These we will describe in detail.

The central cellular portion consists, at its very anterior extremity, of what appears to be a two-celled layer. From a con-

sideration of the history of this structure, these would appear not to be true cells, but rather to represent vacuoles which have become filled with gelatinous substance. As we proceed towards the tail, we find other layers intercalated between these, so that a longitudinal section shows from three to five or more of such layers irregularly disposed. As shown in the diagram, the notochord penetrates into the head beyond the auditory capsules, which are seen on either side of it, and terminates almost close to the mid-brain in the region of the pituitary body, with which, however, it has no connection. The cellular portion is not a straight rod, but is composed of a number of slight constrictions and expansions, caused apparently by the pressure at intervals of the fibrous sheath with which it is surrounded.

This sheath does not entirely envelope the central portion, for it is attached, as shown in the diagram, to the first constriction immediately behind the auditory capsules. In front of this the cellular portion is surrounded only by the delicate second layer, spoken of before. This layer, which envelopes the whole notochord, is very similar to the membrane mentioned in the last article as surrounding the pro-renal ducts and all other organs at this period. It consists of a number of delicate, nucleated, spindle-shaped cells, broad in the centre, and terminating in points where they are attached to each other.

The external sheath consists of a number of parallel fibrous bands, having much the appearance of muscular tissue. This sheath, with the notochord proper within it, can be seen in the majority of the sections already described. It contains not only the gelatinous rod and its covering proper, but also the great double nerve-cord, which ultimately forms the spinal cord. As the anterior portion of the sheath certainly extends under that portion of the spinal cord known as the *medulla oblongata*, whilst it does not surround it, there would appear to be an opening on the dorsal side of the sheath, whence the nerve-cord penetrates it just at the point where the medulla oblongata narrows down into the medulla spinalis. An external view of the sheath shows it to be composed of a number of irregular, transparent ridges, connected by depressions, so as to form what almost looks like a series of waves (Pl. XIX., Fig. 4).

In this figure there will be observed six dark patches, marked *ga.*, which are also surrounded by the sheath. These are six of the ten sympathetic ganglia, lying immediately below the spinal cord proper, and not yet apparently connected by any commissure. These ganglia are intimately connected with structures which have been called the supra-renal bodies, which Balfour considers to be actually developed from them.

My sections of March 10th, as drawn in Plate XXI., Figs. 1, 2, and 3, give most interesting and instructive details of one stage in the growth of the notochord and its sheath. From the peculiar form of the embryo at this stage, these sections show both transverse and longitudinal strictures from the same animal. In Fig. 1 we have a transverse section of the notochord (*nc.*), together with the terminal attachments of the fibrous sheath, both anteriorly and posteriorly. In front, the origin of the fibrous bands is seen to occur at the junction of the epiblast with the brain, the fibrous bands rapidly narrowing down to a single line, so that at these points on either side of the brain the three structures—epiblast, forebrain, and fibrous sheath—are so closely connected and amalgamated, that no distinction can be perceived between them, although they immediately separate from each other and become most distinct structures. Posteriorly, these bands, after closely surrounding the notochord, spread out distinctly, and then immediately commence to lose their fibrous character by resolving themselves into a number of separate roundish cells, arranged in about five rows, which gradually coalesce and run between the epiblast and undifferentiated yelk-mass, at first in two rows and ultimately in a single row of cells, forming a line of mesoblast.

In the same figure as that giving a diagram of the notochord (Pl. XIX., Fig. 2) will be found a sketch of the auditory capsules (*au.*) of the same date, together with indications of nerve-substance proceeding from the brain to them. These auditory capsules on March 9th were distinctly seen to be formed by an invagination of the epiblast. At that time they appeared to be nothing more than a pear-shaped sac, having a very minute opening on the exterior. As seen in Fig. 2, Pl. XIX., they consisted of a sac containing much detached granular matter, the

walls of the sac being formed of a series of almost rectangular cells, placed side by side, being transformed epiblastic cells.

In Pl. XIX. and Figs. 3, 6, 7, 8, and 9, Pl. XX., respectively, will be found diagrams and sketches of the eye at various periods. Figs. 6 and 7, Pl. XX., are diagrammatic representations of the evolution of the eye, as usually given in text-books on physiology, the remaining figures being drawn from various sections of my own to illustrate the appearances presented by this organ at different dates.

Lankester, who first worked out the development of this organ, states that it appears as an oval pit of the epiblast, the edge of which is formed by a projecting rim. The edges of this pit gradually approach each other, whilst the epiblast lining of the floor thickens. The cavity thus formed is eventually converted into the inner optic chamber. A layer of mesoblast next grows in between the walls of the sac and the external epiblast. The iris and lens arise nearly simultaneously, the latter appearing to proceed from the epiblast. In Fig. 8, Pl. XX., and Fig. 3, Pl. XIX., this lens may be seen situated between the horns of the invaginated epiblast, but, as shown in the latter figure, now covered completely by an epiblastic layer, transformed into skin. In both these figures the nerve-cords proceeding from the brain to the eye can be distinctly traced, and in Fig. 5, Pl. XIX., we have a representation of the roots of these nerves as they proceed from the brain itself. The interior of the eye at this date is filled with a transparent substance radiating from the exterior to the interior, where most, if not all, of these almost transparent fibres terminate in a small knob quite as transparent as themselves.

In his article on the "Development of the CEPHALOPODA," Lankester gives an account of the first formation of the lens of the eye. He says:—"It is formed entirely within the primitive optic chamber, and at first depends as a short, cylindrical rod from the middle point of the anterior wall of that chamber—that is to say, from the point at which the chamber is finally closed up. It grows subsequently by the deposition of concentric layers of a horny material round this cone. No cells appear to be immediately concerned in effecting the deposition, and it must be looked upon as an organic concretion, formed from the liquid

contained in the primitive optic chamber." Ultimately the lens assumes a nearly spherical form, being composed of concentrically arranged layers.

In Pl. XX., Fig. 9, we have a peculiar section of the eye, which appears to show one stage in the formation of the retina and its connection with the optic nerve; but it possesses so many points of resemblance to Lankester's description of the formation of the lens (above quoted), that since reading this I am in grave doubt as to whether it does not refer to the lens and surroundings. Although not well shown in the diagram, the central, suspended oval portion consists of two or three concentric, transparent layers, and as shown is entirely unconnected from every other part except by its point of attachment.

In the "Philosophical Transactions" for 1871 may be found a minute and interesting account of the development of the skull of the frog, by Dr. Parker, together with splendid diagrams of various stages in that development. Fig. 1, Pl. XIX., shows one stage in this development, as seen in a section of March 18th. In this we see the branchial arches on each side (*br.*), together with some gills, the formation of these having well commenced as apparent outgrowths of the epidermis. The growth of these gills reminds me very closely of the manner of reproduction by budding which occurs in the hydra. A knob first makes its appearance, the epidermis having all the appearance of being stretched and pushed outwards by some inward force, which, continually acting outwards and forwards, converts the knob into a rounded protuberance.

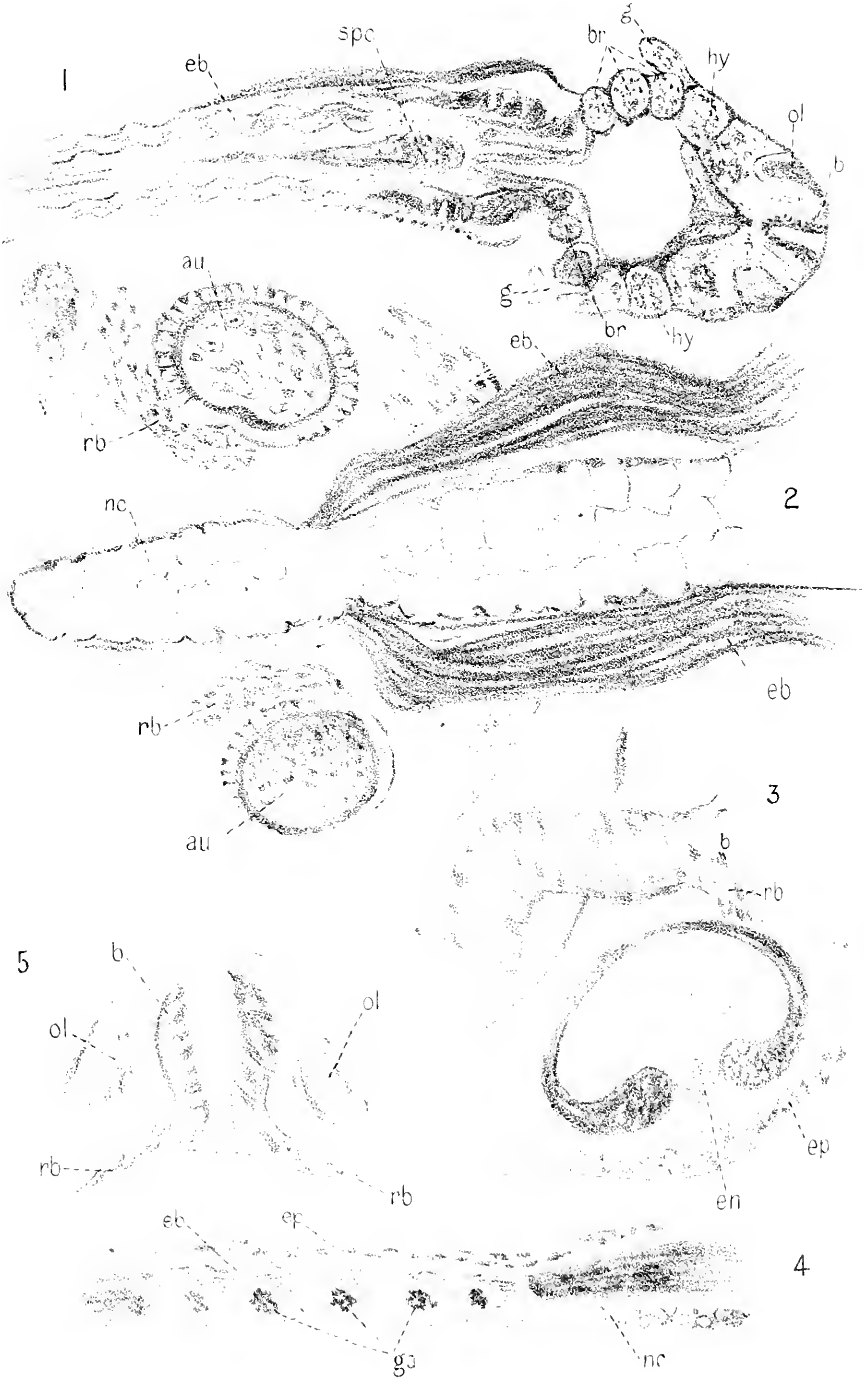
Two or three other smaller knobs form on this (Fig. 2, Pl. XX.), and when the original gill has thus increased considerably in length, it buds laterally, forming a rake-like structure, through which the blood courses bathed externally by the water. These gills are perfectly transparent, the course of the blood-globules being distinctly observed. The blood does not at first seem to follow any definite course through the gill-substance, but for a time appears to take the line of least resistance, soon, however, to become imprisoned in definite channels, the globules following each other in the most orderly progress.

I was once looking at a specimen in which the gills were about

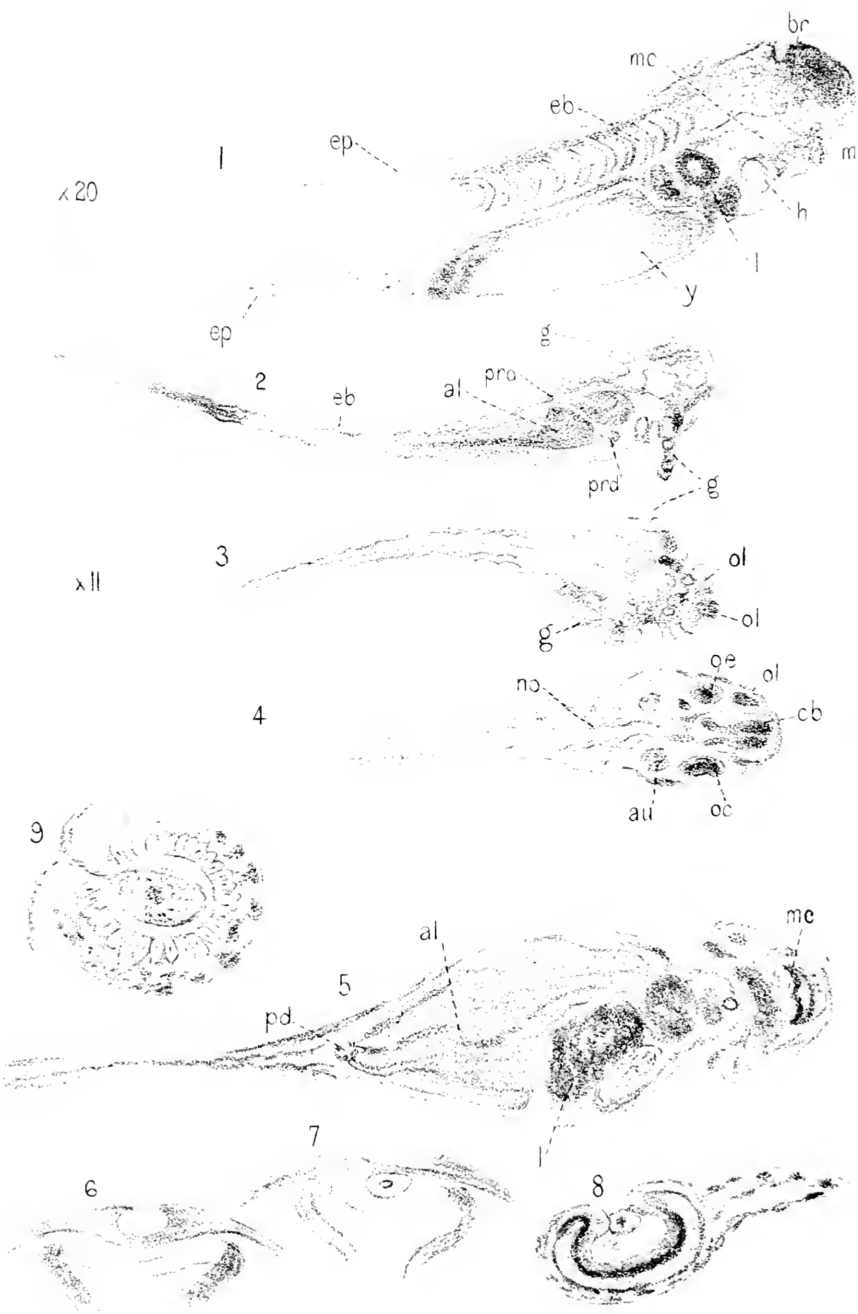
one-half or a little further grown in which no movement could be detected, but the blood-globules were seen lying perfectly still here and there in the tissue. Suddenly, one of these gave a convulsive throb, moved onwards slightly, retreated a little, then with a final start moved forwards on its course, the rest following. Was this, I wonder, the effect of the first true heart-beat which I observed, giving an impulse to the whole of the globules throughout the body, destined henceforth to act as carriers of nourishment to the whole system? Possibly, however, it may only have been the commencement of renewed circulation, which had been temporarily suspended on account of my own rough handling. Whatever may be the correct explanation, the phenomenon was most interesting and curious, having all the appearance of dead and inert matter waking suddenly into life and continuing in that life.

To return to our diagram, we notice not only the branchial arches with the gills, but also the hyoid (*hy.*), mandibular, and trabecular arches. Another section of the mandibular arches is shown in Fig. 6, Plate XIII., where they are seen supporting the mouth cavity (*m.c.*).

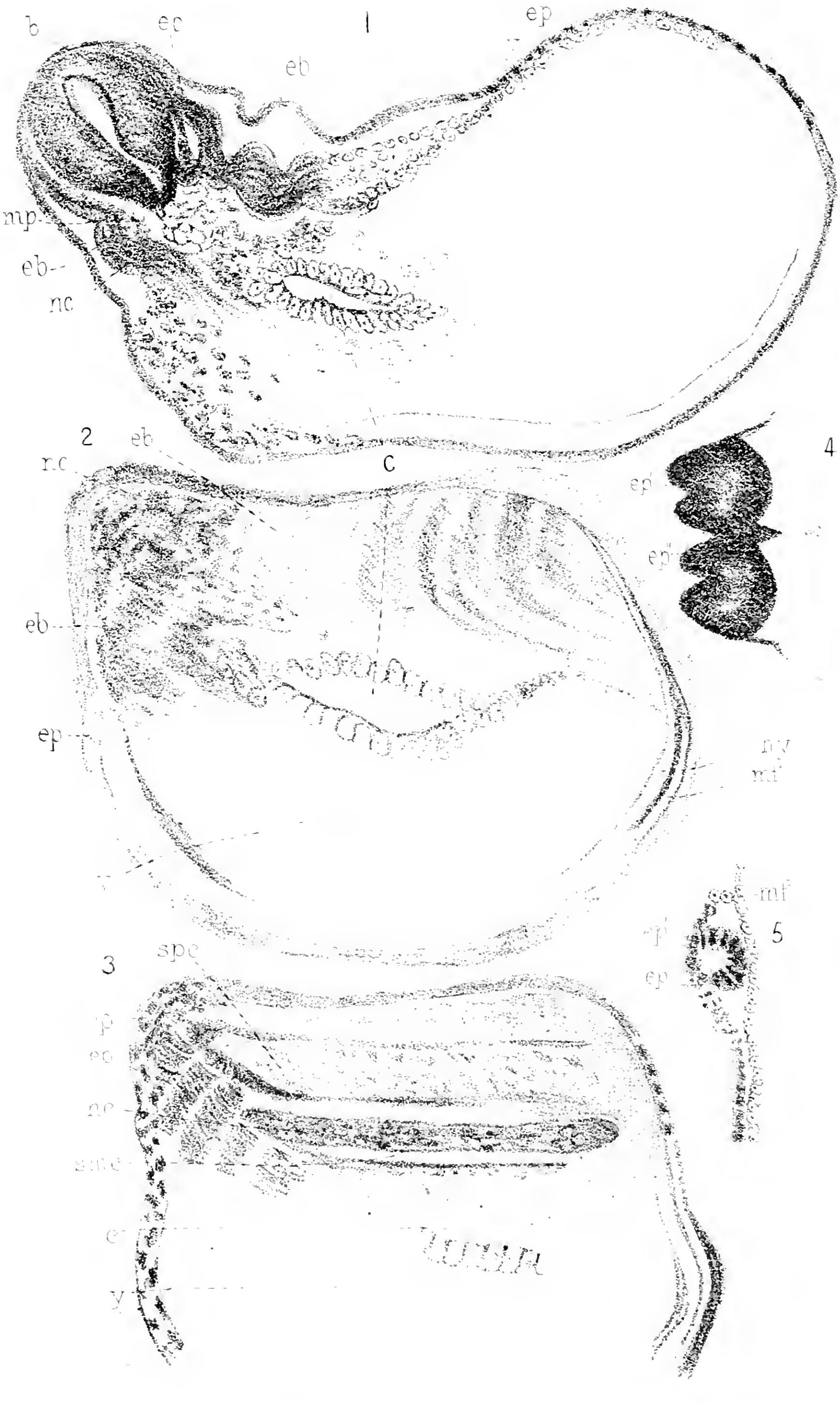
It will be remembered that these observations were primarily undertaken to obtain if possible some definite information on the food of the tadpole. Reference to Figs. 1, 2, and 3, Plate XIII., as well as to Figs. 1 and 5, Plate XX., will show that, although up to March 23rd, the date of these sections, the mouth cavity was well formed, yet the animal could not possibly eat, as the mouth was not only closed, but perfectly covered with the epidermis, although the papillæ on the labials had commenced to form, as well as the salivary glands at the sides of the mouth. Up to this date it will, therefore, have been manifestly impossible for these embryos to have obtained food through the mouth, as mouth there was none. Nourishment, however, must have been obtained; for during the month now elapsed, the eggs had increased both in weight and bulk, and as we have seen, had become so wonderfully altered in form that there was now no resemblance to the original spherical contour. All nourishment would, therefore, up to this date, appear to have been imbibed from the water through the epidermis; but in a few days—namely, by March 29th—the lips



Development of Tadpole



Development of Tadpole



Development of Tadpole

were fully formed, the mouth had opened, and the gills, on the right hand side, had commenced to atrophy.

On March 30th, as far as my observations went, these little creatures took their first meal. In our next we shall see of what this and future meals consisted.

EXPLANATION OF PLATES XIX., XX., XXI.

Plate XIX.

Fig. 1.—Longitudinal Section of Tadpole, March 18, showing the attachment of the elastic band to the notochord.

,, 2.—Front portion of notochord and auditory capsules (same date),

,, 3.—Horizontal section of eye, with root of optic nerve proceeding from the brain.

,, 4.—Portion of notochord, with sympathetic ganglia.

,, 5.—Olfactory capsules, with portion of brain showing nerve roots proceeding to the eye.

Plate XX.

Figs. 1—5.—Horizontal and longitudinal sections, taken March 23.

,, 6—7.—Diagrammatic sections of eye.

,, 8—9.—Sections of same, drawn from nature.

Plate XXI.

Figs. 1—3.—Oblique sections of tadpole, March 10th, showing arrangement of elastic band and notochord.

,, 4—5.—Claspers.

sp.c., spinal cord; *e.b.*, elastic band surrounding noto, chord; *g.*, gills; *hy.*, hyoid arch; *ol.*, olfactory capsule; *b.*, brain; *nc.*, notochord; *au.*, auditory capsule; *n.b.*, nerve-roots from brain; *ep.*, epidermis; *en.*, lens; *ga.*, ganglia; *m.*, mouth; *m.c.*, mouth cavity; *l.*, liver; *h.*, heart; *br.*, brain; *pr.d.*, pro-renal ducts: *al.*, alimentary tract; *o.c.*, optic capsule; *pd.*, proctodeum, changing ultimately into cloaca; *m.p.*, muscle plate; *s.n.c.*, sub-noto-chordal rod.

Fogs.

By Beatrice Taylor.

JOHN Aitken, of Edinburgh, seven years ago, proved experimentally that the presence of dust was essential to the formation of fog and cloud. More recently, it has been shown that fog may be cleared by the discharge of electricity in a fog-clouded atmosphere. This dispersion of fog by electricity is, however, at present too expensive a process to be of practical utility.

In order that the reader may understand how Mr. Aitken came to the conclusion that dust was a necessary factor in the production of fog, I will give the experiments that forced him to adopt this view. I will also investigate the case of town fogs, and show that, like the caterpillars of *Microgaster glomerata* * (often abused by market gardeners), town fogs are blessings in disguise.

Here is the first experiment. Two receivers were connected with a boiler. Into one the air of the room was allowed to pass; the other was filled with air filtered through cotton wool, a process which completely frees it from dust. Steam from the boiler was admitted to the receiver containing ordinary air, and immediately a white fog appeared within the receiver. Next, steam was admitted to the receiver containing filtered air. Not the slightest cloudiness was produced, although this receiver was just as full of water-vapour as the one first experimented with. Therefore, we may draw this conclusion: that dusty air—ordinary air—gives a white cloud of condensed vapour; dustless air no fogging.

The question at once suggests itself, Why does not water-vapour condense in its visible form in air free from dust? It has been found that particles of water-vapour do not combine with each other to form a cloud-particle, but that vapour must have a solid or liquid body—a "free surface"—on which to condense. Vapour in pure air consequently remains uncondensed and super-

* The parasite on the larva of the White Cabbage Butterfly, a visitor that should be welcomed by every gardener.

saturated, while in ordinary air dust-particles form the nuclei on which the vapour condenses. Since every cloud-particle is represented by a dust-particle, the more abundant the dust the more dense the cloud.

To return to the experiment. When steam was passed into the receiver containing filtered air, no vapour condensed in its visible form until circulation brought it into contact with the free surfaces of the sides of the receiver, when it gradually condensed on those free surfaces. The density of the fog in the receiver containing ordinary air indicates what a large amount of dust is present every day in the air around us. But the particles of fog do not represent *all* the dust-particles in the air experimented upon. They do not tell the whole truth. That the fog-particles first produced on admission of the steam only represent a small part of the dust-particles present may be demonstrated by the following experiment:—

Let as much steam be blown into a receiver containing ordinary air as will produce a dense fog. Allow the fog to settle, but do not allow any dusty air to enter. After the fog has settled, blow in more steam. Again you will find a dense fog condensed on the dust that escaped the first condensation. Allow this to settle, and repeat the process a number of times, and you will find that there is still fog forming. But after each condensation the fog becomes less and less dense, till at last it ceases to be seen, although on closely looking into the receiver the condensed vapour will be seen falling as rain.

When the steam was blown in the first time, the fog was very fine-textured. Each particle was so small that it floated in the air. After each condensation the fog became less and less dense. It at the same time became more coarse-grained and heavier, and was seen falling slowly. Near the end no fog was visible; nothing but fine rain appeared to be falling. If the air was still further purified, even the rain ceased. In fact, the conditions that obtained in the receiver containing filtered air have been brought about,—the air has become completely freed of dust.

At this point it will be interesting to consider the effect of absence of dust. Every object on the face of the earth would, like the sides of the receiver that contained only filtered air, act

as a condenser. Every blade of grass and every branch of a tree would drip with moisture deposited by the passing air; our dresses would become wet and dripping and umbrellas useless. Worse than this, the inside of our houses would become wet; the walls and every object in the room would run with moisture.

Before going further, I will state what conclusions we have arrived at from the foregoing experiments:—

1.—That whenever vapour condenses in the atmosphere, it always does so on some solid nucleus.

2.—That the dust-particles in the air form the nuclei on which the vapour condenses.

3.—That where there are many dust-particles a cloud appears because each nucleus only gets a small allowance of vapour, and is not made much larger or heavier, so that it continues to float.

4.—That where there are few dust-nuclei, the amount of vapour condensed on each particle increases, so that the size and weight of the whole number of particles increases, producing in them a tendency to settle down. Fogs, therefore, will only be produced where dust-nuclei are abundant.

5.—That if there were no dust there would be no fogs, no mists, and probably no rain, while the supersaturated air would convert everything into a condenser, on which it would deposit its moisture.

But it will be asked, Where does all this dust, so plentiful in the air, come from? And is it the dust we see in a sunbeam? Anticipating these questions, I will explain what the sources of atmospheric dust are. Broadly speaking, anything that breaks up matter into minute parts contributes a share to the general fund. The spray of the ocean, when dried and converted into fine dust, is an important source. Meteoric dust and volcanic dust form probably another source of supply. But where populous districts are concerned, combustion is certainly one of the most important sources. Before, however, giving the experiment by which the importance of combustion as a supplier of condensation nuclei has been demonstrated by Mr. Aitken, it will be well to consider what the fog-producing particles are.

On entering a dark room into which the sun is shining through a small opening in the shutters, the sun's rays have the form of a

luminous bar, which, on looking more closely, we find, is produced by the dust-motes floating in the air of the room reflecting the light and becoming visible as they pass through the path of the beam. And here is the answer to the second question: Are these the fog-producers? No. When air containing this dust is heated or passed through a flame, these motes disappear and the path of the sun becomes invisible. From this we might conclude that air which passes over or through a flame where combustion was perfect ought to be nearly dustless, and therefore ought not to be a good medium for fogs. But we find air that has passed through a flame *is* a good medium. What really happens appears to be this:—The heating of the air by the flame increases the number of particles. The heat would seem to destroy the light-reflecting power of dust by breaking the larger motes into smaller ones, and by carbonising or in some way changing their colour, and thus making them less light-reflecting.

The fact that the products of combustion are fog-producers may be proved in the following way:—Light a gas-flame within a glass tube, and allow the products of combustion to pass into a vessel into which steam can be blown when required.

The result of an experiment on these lines is that the combustion of filtered air and dustless gas gives an extremely fog-producing atmosphere. That the fogging is, however, due to dust cannot be doubted, from the fact that the products of combustion, when *filtered*, give no cloudiness on the admission of steam.

By further experiments, it has been shown that the products of combustion from a clear or smoky fire give about equal fogging, and that of all the substances experimented upon sulphur was the most active fog-producer. In fact, sulphur vapour gives rise to a fog so dense that it is impossible to see through a thickness of two inches, a degree of opacity not yet reached by our London fogs.

From these results, we learn that it is hopeless to expect that by the adoption of fires having a perfect combustion—such as the gas-fires, now so much advocated—we should diminish the frequency, persistency, or density of our town fogs. All fires, however perfect the combustion, are fog-producers when accompanied by certain conditions of moisture and temperature. From this it will be seen that it is not the visible dust-motes seen in the

air that form the nuclei of fog and cloud particles, as these are destroyed by combustion, and yet the air remains fog-producing. No doubt these motes also play their part in condensation, but their number is too small to be of importance. The fog and cloud nuclei are a much finer form of dust, are quite invisible, and though always present in our atmosphere are almost unobserved.

But more perfect combustion will remove the yellow character from the fogs and make them purer and whiter by preventing the production of smoke, which at present mixes with our town fogs and aggravates their character. It is the smoke that prevents them dissolving when they enter our rooms, like a well-conditioned country fog does in a country house.

We all know the saying of the Londoner, "The smuts are falling; there'll be rain shortly." This is how the circumstance comes about :—The smoke-particles are good radiators, are soon cooled, and form nuclei on which the vapour condenses. The smoke-particles loaded with moisture are prevented from rising, and descend into the streets. Therefore, it is perfectly true that the falling of smuts indicates a saturated condition of the air.

There is another point to consider with reference to our town fogs—that is, the fact that sulphur, when burned, is an intensely active fog-producer. Calculation shows that there are 200 tons of sulphur burned with coal every winter's day in London. This, together with the high fog-producing power of ammonia, accounts for the density of London fogs.

Before, however, condemning smoke and sulphur, we must look for their good points. Like the good points in character, they do not lie on the surface and annoy us as the bad ones do.

Full consideration must be given to the value of smoke-carbon, as a deodorizer; so, too, to the powerful antiseptic properties of sulphurous acid, formed by the burning sulphur. The air during fogs is still and stagnant. There is no current to clear away the foul smells and noxious germs that float in the air, which might be more noxious than they are, were it not for the suspended soot and burned sulphur.

Economic Entomology.

PRESIDENTIAL ADDRESS TO THE HIGHBURY MICROSCOPICAL SOCIETY, BY JAMES A. FORSTER.

I PROPOSE in the following paper to give, in the simplest language, some few facts and observations illustrating what I would venture to term "Economic Entomology," and which I would describe as the natural history of the insect friends and foes of the gardener and agriculturist.

The importance of the study of Economic Entomology is, I think, very generally much underrated. The entomologist is too often regarded with a sort of mild scorn as a man who pokes about in odd places and who finds his pleasure in childish pursuits, or as an enthusiast wasting his time over very insignificant things and claiming for them a preposterous importance—in fact, as an example of the old adage that "Small things amuse small minds." This, I hold, is not even just to the mere collector, but when applied to a true student of insect life is simply an opinion born of ignorance. Small in size, indeed, are the animals he studies, but their importance in the economy of nature is very great and the study of their lives a most difficult one, requiring a highly-trained observation, unlimited patience, unflagging zeal, and in addition to these, a humble reverence for Nature; for to the arrogant and careless she will never tell her tale or disclose her secrets. To the insect world we owe our most beautiful dresses, famous and much-esteemed food, and some of our loveliest flowers. On the other hand, some of our direst misfortunes have been occasioned by insects, countries have been devastated by them, nations reduced to the verge of starvation, travelling rendered impossible, flocks annihilated. Surely the study of creatures capable of affording us such benefits and of inflicting such miseries cannot in any sense be deemed futile, simply because they are, for the most part, small in size and insignificant in appearance. Insignificant are they only to our unaided human eyesight. Bring the microscope to our aid, and away vanishes their insignificance, and they stand out revealed in all their

wonder as creatures endowed with a beauty and strength that even the higher branches of the animal kingdom cannot rival.

That the microscope has so furthered our knowledge of, and is so essential to, the study of insect life, I think sufficiently justifies my choice of a subject. I believe the subject is no unimportant factor in one of our greatest national problems—viz., the Agricultural question. For, as it is evident that the conditions of agriculture in this country are undergoing and must undergo great changes, to result, probably, in the giving-up of the old methods and the old productions, and the development of dairy-farming, and the cultivation, at present neglected, of fruit and other products now largely imported from foreign countries—if this comes about, a national knowledge of insect life as affecting agriculture will become of increasing necessity, for with every new cultivation will come new dangers from our insect enemies. Many an insect at present rare in this country, and of no general or economic interest, may, through the introduction of some new crop or some new method of working the land, suddenly become a most formidable plague, placing the prosperity of the cultivator in the utmost peril. Such dangers can only be met and combated with success by a thorough knowledge of these minute creatures: their lives and habits, their histories, and, above all, their enemies themselves, for the most part insects. The majority of farmers and gardeners regard all insects alike as things to be killed wherever seen, and in carrying out this theory murder some of their best friends, while many of their deadliest foes, from their habit of closely concealing themselves or from their minute size, escape detection.

An important element in the education of a farmer should be the teaching the use of the magnifying lens and the naturalist's habit of close and minute examination and accurate estimation of the facts he observes. Indeed, not only for the farmer is this teaching necessary, but I would urge that it, with a general teaching of zoology, ought to form a distinctive part of every boy's education. I mean that Natural History should not (as is now mostly the case where it is taught at all) be taught as an extra subject, but it should have a prominent place in the curriculum of every school, to be taught with as much regularity and

earnestness as grammar or language. These, surely, cannot excel it as a means whereby to train the youthful intellect to habits of close, careful, and accurate reasoning, order, and patient attention. The study, properly directed, of God's creatures can hardly be of less value as a mental and moral training than that of a dead language, and must necessarily bear much more nearly on our daily life.

The insect kingdom—by far the most numerous in species of any corresponding group throughout animal life—is, as you are aware, classified into some twelve or thirteen principal families. Each of these families sends its quota to the host of the insect marauders of our gardens and fields. Happily for us, each group also contains not only species, but entire families, whose object in life is to prey upon these pests, to hunt them down, to devour them in each stage of their life. Thus has Nature put a check upon their increase, without which the human race would quickly have been eaten out of the land. Without these natural allies, we should have been powerless to overcome these deadly if minute enemies—the more deadly, indeed, because of their minute size, which renders it so difficult for us to discover them till the mischief they cause is well-nigh irremediable.

It is, then, evidently of the first importance that we should acquire that knowledge which shall enable us to recognise our friends so as not to confound them in the wholesale destruction we attempt to bring about of our pests. As a first step towards this knowledge, it is to be observed that the Insecta—like the higher animal kingdoms—comprises groups of vegetable-feeders and of flesh-feeders. Now, it is amongst the former that are found those insects that cause the most serious losses to our various crops; while it is to the latter—to the predaceous and carnivorous class—that we are indebted for the keeping within bounds, the enormous increase of the devourers of our fruit and food that would otherwise take place by reason of the wonderful powers possessed by them of reproduction. It is thus, as in so many instances throughout life, that Nature provides, as it were, a natural balance of forces, and I would ask, What can we do more wisely than avail ourselves of Nature's own means of keeping in check the myriads of foes that would, if left to themselves,

turn our fields and our gardens into barren wildernesses? Had our hop-growers perceived the truth of this, and persistently and patiently fostered by every means in their power the settlement in their gardens, and the increase, of aphis-eating insects, such as the Lady-birds (*Coccinellidæ*), they would have largely mitigated, if not entirely prevented, the almost incalculable losses they have suffered from the so-called "black blights," which, instead, have become of increasing frequency during the past fifty years. The great loss caused by the ravages of aphides alone to hop-planters and the whole community may be well brought home to us by the following facts and figures:—

In 1882 a serious blight occurred throughout the hop-growing districts of England, causing a reduction of the average production from 7 cwts. per acre to less than $1\frac{3}{4}$ cwts. Now, as in that year the hop acreage was about 65,600 acres, the total yield of which was under 115,000 cwts. instead of 460,000 cwts., it follows that the loss on the crop was about 345,000 cwts., which, taken at the average price of hops for the preceding twenty years (£7 7s. per cwt), amounts to over £2,500,000 sterling loss in that year to the cultivators alone. But it was not they alone who directly suffered for it. It is estimated that not more than £150,000 was paid that season for the picking of the crop, while had it been an average one, the cost of picking would have amounted to nearly £400,000. So nearly a quarter of a million sterling was lost to the labourers in that one season. What an amount of misery is expressed in these figures!

A few facts concerning our apple-orchards may further serve to justify my claim for the economic importance of my subject. There are in England, according to recent agricultural statistics, at least 250,000 acres under fruit cultivation, of which by far the larger part is occupied by apple-orchards, forming a very important item in the crops of many districts in Devon, Somerset, Herefordshire, and Kent. Now, the apple, amongst its many enemies, suffers from the attacks of two little moths and their caterpillars—the small Ermine moth (*Hyponomenta padella*) and the Codlin moth (*Corpocapsa pomonella*). The former, in the years 1865 and 1887, entirely devastated whole orchards throughout Kent and also the West of England. Hundreds of acres of orchards were

to be seen in the month of July of those years without a leaf upon them—as bare, in fact, as though in mid-winter. Every leaf, every bud, every blossom, had been cleared off by innumerable swarms of Ermine moth caterpillars, which had not only entirely destroyed the crop for the season, but had so seriously injured and weakened the trees that they produced but very small and poor crops in subsequent seasons. Again, in 1880, much damage was done by the same insect.

In 1877, the second of the above-named moths, the Codlin moth, caused much mischief to the orchards of Kent, where, it was estimated, about thirty per cent. of the apples fell immature by reason of the maggot having penetrated to the core. And, further, it was found that a large portion of the fruit that did ripen would not keep from the same cause. As this moth specially attacks pippins and the choicest descriptions of dessert apples, the pecuniary loss to the growers must have been very large; but as there are no official statistics it is not possible to estimate the amount. In the cider-producing districts, the destruction of half the crop, which frequently takes place through the ravages of these two insects, must represent a very heavy loss to the farmers. Very frequently the above mischief is attributed to the weather, to the east wind, to that all-embracing word when used by the gardener, "Blight"; but if the observers would look closer and more accurately the true enemy might easily be discovered. When a gardener, seeing one of his trees with all the leaves shrivelled up, drawn together, and enveloped, as it were, in cobweb, with the blossoms falling off before mature or not opening at all, tells you in a mysterious manner that there is a "blight in the air" or that the tree is "struck," he is only confessing his ignorance and want of observation, and consequent inability of taking such precautions as shall render a recurrence of the misfortune unlikely or at any rate less severe.

The limits of this paper and my lack of knowledge alike render it impossible for me to attempt more than to describe a very few of our insect foes; but these that I shall now mention will serve as a sample of the rest, and the consideration of their life-histories will, to some extent, indicate the methods of observation necessary for their study. As I have already said,

each of the great insect families contributes its quota to the devastating army. Certain families—notably, the Beetles (Coleoptera), the Bees, Wasps, Ants, etc. (Hymenoptera), the Ephemeras, Dragon-Flies, etc. (Neuroptera)—send us friends as well as foes; others—like the Aphides (Homoptera) are unmixed evils. The Aphides are, perhaps, the most terrible and dangerous of all our scourges, and one of the most difficult to overcome, their amazing power of increase being unequalled throughout the animal kingdom. There is scarcely a plant that is not attacked by them, nor a locality where they are not to be found in numbers, and, under their popular name of "blight," dreaded by all gardeners and cultivators. At first sight it would hardly seem that they could be worthy of much attention. Their round, short bodies, nearly all belly, are carried on the frailest of legs; their habits are so sedentary that they seem intended to remain stationary; where they are born, for the most part, there they live and die, without giving any evidence of the instinct so frequently met with in insects. Their lives might almost be described as vegetable. Yet their organisation is most singular, and their fecundity in certain seasons so prodigious as to make them a real scourge. They infest every kind of tree, plant, or flower. The rarest flowers in our hot-houses and the commonest flowers of the hedgerows alike serve them for home and food; in short, they are of all climates and all seasons.

They are both oviparous and viviparous. Their eggs, fixed to the plants by a viscid secretion, have the appearance of little, black, oval, shiny grains, deposited irregularly in large numbers on the sheltered side of branch or leaf. The young larva when extruded from the egg is nearly of its full size, and presents but little difference in appearance to the perfect insect. It emerges from the egg by a sort of trap or cover, and falls out backwards. Shortly after their birth, the young aphides work their way on to the tenderest and greenest part of the plant on which they find themselves. They crowd close together, their heads usually pointing to a common centre, and fix themselves by means of the large beak with which their mouth is furnished, and through which they incessantly suck up the sap of the plant, exhausting it and causing strange excrescences like galls, and in the end the plant becomes

deformed and ruined. When three days old, the larva changes its skin ; this is repeated three times at similar intervals. For the greater number, these metamorphoses produce but little change in appearance beyond a small tail, which develops at the end of the abdomen. When about nine days old, the female aphis (conditions of food and temperature being favourable) begin propagating their species by giving birth to living larvæ without having had any connection with the male. This has been described by Professor Owen as follows :—

"This larva, if circumstances of food and warmth be favourable, will produce a brood—indeed, a succession of broods of larvæ—like itself without connection with the male. In fact, no winged males will have appeared. If the virgin progeny be also kept from any access to the male, each will again produce a brood of the same number of aphides, and carefully prosecuted experiments have shown that this procreation from a virgin mother will continue to the eleventh generation before the spermatic virtue of the ancestral coitus has been exhausted."

In favourable seasons, a certain portion of the third and fourth of these viviparous generations undergo special changes. At the first moulting small processes are observed on the back. These at successive moultings become largely developed, and after the fourth and last change of skin appear as large, fully-formed, transparent wings, on which the insect can fly away to fresh fields and pastures new. These winged aphides produced during the summer are always females. When two or three days old they take their flight to found new colonies. After the fourth generation, no further winged females are produced.

Towards the end of autumn the generations, usually eleven in number, approach their close, and the last brood produces a certain number of winged males, who fly off in search of partners. Reproduction then follows its normal course. The females, after marriage, give birth to no more living larvæ and produce only eggs. These remain during the winter protected by impervious shells from the cold, which would destroy the soft larvæ. In the spring these are hatched, producing larvæ as already described, who in their turn repeat the viviparous generations.

This is a brief outline of the life-history of the aphis family,

which contains many species, many of them only too well known to most of us, like the Hop-fly (*Aphis humuli*). There are various species peculiar to certain fruits and plants. Indeed, each fruit seems to have its special aphis. Thus, we have the Apple Aphis (*A. mali*), the Plum Aphis (*A. pruni*), the Currant Aphis (*Rhopalosiphum ribis*), and many others. Mr. Whitehead writes of the Apple Aphis :—

"The Apple Aphis, or Green Fly (by which appellation it is better known), derives its food solely from the juice of the leaves and blossoms. It makes its appearance as soon as the buds begin to swell and the leaves show signs of coming forth, and it follows up the blossoms from their earliest development. The aphis attacks the blossoms, being specially attracted by their saccharine qualities, and either prevents the process of fructification or so besets the tiny fruits that, weakened by the extraction of their juices and begummed with viscous honey-dew, they are unable to set properly. The fruit that perchance survives rarely attains to full size, shape, or quality. As the leaves come out, their under surfaces are occupied by the aphis, and soon curl up, get black, and fall off, leaving the trees bare, and emitting a sickly smell from all sides."

The aphis is one of the main causes of apples falling immature from the trees, and also largely affects the quality of the cider in certain seasons. This species is found all over the world. The Americans, however, claim that the pest was introduced in their orchards by trees brought from Europe. Another species very injurious to orchards is known as the Woolly Aphis, or American blight (*Schizonema lanigera*) Everyone who has closely noticed apple-trees will have frequently remarked knots or bunches of a downy or woolly substance on parts of the stems and in interstices of the bark. This is very frequently supposed to be a form of mildew, but if closely examined it will be found that this woolly substance covers little groups of aphides, all actively engaged in extracting the sap. This form is specially liable to attack newly-pruned trees if the cutting has been done carelessly. Old and neglected orchards, of which there are too many, are the special home of this pest, the lichenous and moss-covered stems exactly suiting it and enabling it to remain unsuspected, while the

trees attacked become after a time covered with swellings, checking leaf and blossom, and ultimately causing both stem and twigs to decay. This state is frequently called canker, and is attributed to any cause but the right one—the exhaustion brought about by the persistent suckings of myriads of larvæ.

I have dwelt much longer than I intended on the Aphis; but before I pass on to other of our insect troubles, I must say a word or two about the Phylloxera (*P. vastatrix*), which, although not occurring in this country, has produced such wholesale destruction in the French vineyards, that its name has become known throughout the claret-drinking world. The Phylloxera is a species of Aphis of very small size, and somewhat different in form from the species known in this country. It first appeared in France about the year 1863 or 1864, and is supposed to have been brought from America. It attacked first the Gard district; then rapidly spread to the south and west. Its minute size renders it almost indistinguishable without a glass, and its appearance is like a little yellow powder adhering to the stem of the vine. It is oval in form, is furnished with two vigorous antennæ, and has an articulated beak more than half the length of its body. This, when not in use, is folded against the lower side of the thorax, where it lies between the six little legs. Its body tapers somewhat towards the extremity. Their changes and metamorphoses are very similar to those already described. Towards the twentieth day of their life, on their attaining the adult stage, their abdomen enlarges on the sides, and four mamelons appear, and immediately after the insect lays a batch of eggs. Each female lays about thirty eggs in each batch, and as there are eight generations each year, the six months between April and November suffice to produce such a horde of the voracious creatures that more than half the vineyards of France have been destroyed by them. And even supposing means be found to extirpate them, it will require ten years for the mischief to be made good and the vineyards restored.

The evil caused to the vine by the Phylloxera is a complete draining of the sap from the stems. They attack only the main stems, which furnish them most abundantly with the nourishment they require. In spite of the attack of these countless living

pumps, which work incessantly, the vine-stems continue a most rapid growth, more so than if in their normal and healthy state; but they become yellow instead of white, then gradually pass to brown, the shrivelled bark serving as a lair for the Phylloxera. As the evil continues, the bark becomes more and more folded and shrivelled, until at last it assumes a blackish tint and falls in a state of decay. The insects then abandon it to make fresh attacks on fresh vines. Failing fresh plants, they attack the principal roots, destroying their outer coverings after penetrating well below the bark. When one root is annihilated, they work underground to another, occasionally coming on to the surface of the ground to hunt for healthy vines.

If not easy of detection in the commencement, the Phylloxera cannot be overlooked after a time. After a vineyard has been infested for two or three years, the stems attacked underground produce only a leaf here and there. These are small and malformed, and after languishing for a time turn yellow and roll up. The whole plant dwindles, the grapes, arrested in their development, hardly form, the pips split up, all fructification disappears, the leaves get thinner and smaller than ever, and soon the vineyard presents the aspect of complete ruin. And ruin it is, for the only cure is the thorough burning of the old vines.

Many remedies have been suggested, but I do not think any have been attended with much success. M. Dumas proposed the employment of a concentrated alkaline solution of sulphate of potassium, or soda, and the ammoniacal sulphate produced in gas works. It is believed that this, if carefully used, would be efficacious, as the Phylloxera would be poisoned and the vines probably much benefited and strengthened by this chemical manure, but one important difficulty arose, viz., the question of expense, which is prohibitory.

Monsieur Bazille, of Montpellier, is stated to have employed with success, a dressing composed of cow's urine, an alkaline sulphate, and $^1/_{10}$ of oil or tar. I, however, think the true and practicable preventive for the attacks of the Phylloxera has yet to be discovered, and considering the immense interests at stake, such a discovery would be well worth making, and the discoverer would deserve well of France and the world.

The chief natural enemies of the Aphis family are found among the Beetles (*Coleoptera*), one family of which, the Lady birds (*Coccinellidæ*), are the great destroyers of Aphides, on which these beetles, both in their larval and perfect states, feed with the utmost voracity, and no better precaution can be taken against the attacks of "Blight" than the colonisation of Lady birds in our gardens. Another most valuable insect ally for this purpose, is the common gauze-wing fly, sometimes called the "Stink fly" (*Chrysopa perla*). It is well known in gardens, is delicate green in colour, has a long, thin body, four very delicate wings, and two exceedingly bright golden eyes. When handled it imparts to the fingers a most disgusting scent; hence its name of Stink fly. This fly in the perfect state preys on the Aphis, hovering over the infested plants, alighting from time to time to snatch up some of its living food; but it is in the larval state that it does the most execution.

Among beetles we have many enemies, notably among whom may be mentioned the Skip Jacks (*Elateridæ*), known in their larval condition as Wire worms; the May bugs and their allies (*Melolonthidæ*); the Weevils (*Curculionidæ*), attacking corn, etc., in store; the Corn Beetle (*Trogosita Mauritanica*); the Meal worm, another of the same family; the Pea Beetles (*Bruchidæ*); the Pea Weevils (*Sitonidæ*); the wood-boring *Hylesinidæ*, of which the *Scolytus destructor*, too well known in our parks, is a good example; the family of *Longicornes*, deadly enemies of forest trees; and the *Chrysomelidæ* or Golden Apple Beetles. It is evident the limits of this paper would not permit me to give a life history of each of these destroyers. They are, with a host of others I have not enumerated, formidable destroyers, largely and directly affecting the profits of the farmer, though very frequently he has no idea of the cause of the failure of his crop, perhaps does not even know of the existence of the tiny ravager who has robbed him of the fruit of his toil. Take, for instance the Wire-worm. This (*Agriotes lineatus*), in its perfect state, is a narrow brown beetle about $^2/_5$ of an inch long, with long wing cases or elytra covered with parallel lines. They present somewhat a flattened appearance, and the thorax is produced into spines at the hinder angles, and underneath, the breast plate is produced into a long point. They are remarkable for their great power when placed on

their back, of jumping or throwing themselves into the air by means of a sudden jerk of the thorax, in effecting which the thoracic prolongations come into their places with a sharp sound like the shutting of a spring. Hence their popular name of Click Beetles or Skip Jacks. In the perfect state it is probable the beetle does little or no harm to the crops, but in the larval stage it is most formidable. The larva is something like the meal worm, but more slender and elongate; it is yellow and exceedingly tough, like wire, whence its familiar name of Wire worm. They have, I believe, no eyes, but possess a short, four-jointed antennæ, and are furnished with short, robust legs set close together. The apical segment, possessing an anal prolongation, is especially hard and frequently toothed; they are found everywhere at the roots of plants.

The attacks of Wire worms are most serious to sainfoin and clover crops, also to pasture lands, the finer grasses being invariably chosen, and the frequent failure of the grass seeds results probably more often from the work of the Wire worm than from any other cause. It is throughout the United Kingdom a continual source of harm and loss to every description of corn crops. The Wire worms fix their heads into the soft part of the stems, and with their hard, strong jaws gnaw away the tissues so as to entirely arrest the circulation of the sap. The insect remains in the larval state for several years (the limit generally accorded is five years), but it is difficult to ascertain the exact period. It is this long, larval stage that causes them to be specially dangerous to those crops, such as sainfoin, that remain on the land two or three years. When full grown the larva descends deep into the earth to undergo its transformation. It remains for a fortnight in the pupa condition, when the perfect insect emerges and comes to the surface of the ground. Fortunately this pest may be got rid of. A field that is infested with it should be thoroughly and deeply ploughed and scarified, and all growth in the soil rigidly destroyed. It should then lie fallow for a winter, and in the spring again carefully gone over to stop all weed growth, then be sown with tares. After this a crop of mustard should be put in, and the Wire worm will be effectually starved out, for numerous experiments have proved that it cannot eat either of these plants.

Other classes of Insect Enemies are the Cecidomiters or Midges, of which the little Wheat Midge may be seen at most seasons flying in swarms on the edge of wheat fields. These later on deposit their eggs within the wheat ears. The eggs soon hatch out little white maggots, which then bury themselves into the stigmata of the flowers of the wheat plant, thus hindering the development of the grain, and frequently reducing the crop by a fifth or more. In some years the amount of destruction occasioned by it is very great.

Another most mischievous insect and very troublesome to get rid of is the well-known Daddy-long-legs (*Tipula oleracea.*) The female fly is stated by Curtis to contain some 300 eggs, forming a mass which fills nearly the whole of the abdomen. These she deposits in the autumn on the grass, they hatch out in the early spring, and burying themselves into the ground soon grow into dirty-looking grubs, an inch long, having very tough skins. They are destitute of legs, but still have the power of burrowing rapidly in the ground. They make their burrows a little below the surface of the ground and among the roots of the grass on which they feed. So actively do they work and feed that they quickly kill off a patch of grass, and their presence underground is then made known by an ugly brown dead patch on lawn or field. The best remedies we can avail ourselves of against these pests are the birds, especially rooks and starlings, and also the much slandered moles, which, as devourers of grubs of all sorts, wire worms, etc. are simply invaluable, and should be cherished instead of being killed and trapped as noxious vermin.

The injury we suffer from the Caterpillars of Moths and Butterflies is probably much better known than that caused by other classes of insects ; still, the ignorance of gardeners and cultivators regarding these creatures, which are comparatively so easy of observation, is astounding Among the lesser known, but not the less dangerous on that account, are the caterpillars feeding in the interior of the stems of various plants and shrubs; one of these, the clear wing moth larva, will serve as an example. The moth is small, having more the appearance of a fly than a moth, its wings being almost destitute of scales; it lays its eggs on the bark of currant-bushes. The larva on emerging from the egg

immediately eats into the middle of the stem and then continues eating its way along the pith, always working upwards. It goes on feeding the whole of the autumn and a good portion of the winter, and emerges as a moth the next summer. When a bush is attacked by this creature nothing can save it, and the only thing to be done is at once to cut away right down to the ground all the doubtful stems and carefully burn them. This should be done in the winter.

I have now touched in the most superficial manner upon four only out of the 13 orders of insects, but I have more than exhausted my space and I fear my readers' patience. If, however, any remarks of mine shall induce anyone to study and observe the lives of these creatures that are competing with us for our food, I feel sure I shall have done some good. The field of research into the lives and habits of insects is open to all, and the knowledge to be gained is probably of far more importance to the world and likely to result in more direct gain to mankind than most of us dream of.

Finally, I would venture to suggest that the study of insect life is just the work a society such as ours might most usefully follow up. I have always considered that we, as a society, would be likely to be more successful, if each season we set ourselves some special task, some subject to be thoroughly worked out and ventilated at our meetings. We should thus certainly secure new interests and pleasures in helping each other in our common study, and should further justify our existence as a scientific society.

The Discovery of boulders in coal-seams has raised a difficulty concerning the usually-accepted doctrine that beds of coal have for the most part been formed of the remains of trees and plants that grew on the spots where coal exists. It is now thought that the immense beds of vegetable matter could never have grown *in situ*, but that they have been carried down from mountain-sides by avalanches. Examples of this kind may be seen in the lakes of Ancient Tyrol, of which the Aachensee furnishes the most striking. In its deep, clear water, hundreds of trees may be seen in an upright position, which have become soddened with water and then have sunk to the bottom. The fjords of Norway also afford examples. If this theory be correct, the presence of boulders can be easily accounted for.

On the Male Generative Organs of Two Species of Cypris:
Cypris cinerea and Cypris minuta.

Plates XXII. and XXIII.

By T. B. Rosseter, F.R.M.S.

BRADY, in his excellent monograph on the "Recent British Ostracoda," published in Vol. 26, Trans. Linnean Society, p. 374, places in the sub-genus *Cypridæ* (Zenkier) a new species, and gives it the specific name of *Cinerea*—ash-grey. He says:—"It is distinct from any other British Cypris, and that he has not been able to identify it with any of the numerous species described by continental authors." It is plain, from Brady's description, that he had only the female under consideration, for he is silent about the male, but so exact is his description of this species, that anyone having made himself acquainted with the results of his investigations could not fail to recognise it when seen. He only found it in one locality, viz.—in a pool on the summit of Mickel Fell, Yorkshire, at an elevation of 2,000 feet. It was during the month of December, of last year, that in a stock-bottle, containing both sexes of *C. minuta*, I found some specimens of Cypris, unknown to me, but which proved afterwards, on reference to Brady, to be females, and one solitary male of *C. cinerea*.

During the month of June last, I found both males and females of *C. cinerea* in a pond at Churchwood, at an elevation of 220 feet, the property of the Dean and Chapter of Canterbury Cathedral. I have not found it to be common, and do not think it is so. When I discovered it, I plumed my feathers and fancied I had found a new species, not only of the female, but of the male Cypris also. At this time, I was conversant only with "Baird's British Entomostraca," and could find nothing there to satisfy my mind in connection with it. Not being aware that Brady had discovered and described it, I made some careful notes of both sexes, and, although I must confess I was somewhat dis-

appointed to find subsequently that the female was known to Brady and that I was only second in the field, still, it was a consolation to know that my observations concurred with his, and what was still more gratifying was, that he gave no account of the male, nor did he figure the male genital organs. I came, consequently, to the conclusion that he had not seen it, and determined to continue my investigations in that direction.

The following is a comparative description of *C. cinerea*, male and female :—

Cypris cinerea (male), Rosseter.

Shell, oval; colour, ash-grey; second antenna bears five long setæ, the rest short; its claws, and those of first foot, are not serrated. The second foot bears three setæ, one extremely long, being two-thirds the length of foot, and two short setæ of equal length. Post abdominal-rami as in female, second maxillæ chelate; length, one-fortieth of an inch; breadth, one-fifty-seventh of an inch.

Male organs consist of Bursa-copulatrix, with intromittent organ, and a paired mucous glandulosa testis. Locality, Churchwood, Harbeldown, Canterbury.

Cypris cinerea (female), Brady.

Carapace, oval; surface of shell, finely and closely punctate; colour, ash-grey. The second antenna has three setæ, very long, the rest short; its claws, as those of first foot are long, slender, and destitute of serratures. Terminal setæ of second foot, very stout from base to the middle, then constricted, and tapering to the points. Post-abdominal-rami, stout; claws, short and stout; the lateral setæ, and those on inner border of the ramus, very short and slender. Length, one-thirty-fifth of an inch; breadth, one-fifty-fifth of an inch.

On comparison, it will be seen that there are some particulars in the description of the male which do not correspond with Brady's description of the female, but these are comparatively slight. I allude, in the first place, to the filaments of the second antenna, to which I have given very careful consideration, and find that the same number of filaments exist in both sexes. The long filaments, as they approach their termination, give off very fine branches. These might easily be overlooked, and only

revealed themselves to me under a one-eighth objective, and then very faintly, but with a one-sixteenth immersion they were distinctly seen. I also found that one of the short setæ was distinctly plumose (Pl. XXII. Fig. 5). This is situated on the inner side of the antenna, and is not mentioned by Brady. Again, although it is said the claws of the first feet and second antenna are not serrated, still, near the apices on the inner border, are to be seen some very fine, close-set setæ, which seem to stand out boldly from the margin of the claws. The male is, as a rule, a trifle smaller than the female.

Brady, in order that his new species may be recognised, gives two drawings: one of the post-abdominal rami and the other of the second foot of the female. If we compare the second foot of the male (Fig. 6) and that of the female (Fig. 7) with Brady's drawing of the second foot of the female,* we shall be convinced that one is the counterpart of the other. The long seta of the second foot seems to be an articulated organ, capable of being bent back on itself. The two short setæ are of equal length and rigid; their length is the one-six-hundredth of an inch. This close comparison of the second foot, I think, establishes its identity as the male of *C. cinerea*, for although in outline the bursa somewhat resembles *C. compressa*, the second foot of the latter gives a decided negative to its being that species.

Even to a practical observer, it would be difficult, from external appearances, to distinguish the male from the female. Its conformation is in every respect similar. The anterior portion of the male may, perhaps, be a little more rounded than in the female, but the difference is not very apparent.

The male organs consist of a paired mucous-gland, a paired bursa copulatrix, and intromittent organs. The mucous glands are situated in the posterior portion of the carapace in the dorsal region. They are in apposition one with the other, and are nearly vertical. They are cylindrical, and composed of seven whorls or rings. The five intermediate whorls are beset with long filaments. The anterior whorl appears, when seen *in situ*, to be a perfect circle; the periphery projects from the axis of the body,

* See Plate XXXVI., Figs. 7 and 9, Brady's Monograph of British Ostracoda, Vol. 26, Trans. Linnæan Society.

and is armed with strong spines, which are thickened at the base and tapering towards the end. The posterior is a fac-simile of the anterior. On each end we get a protuberance or crown. When the anterior crown is flattened by pressure—as, for example, by the cover-glass—we find a circular orifice, or stoma, whose diameter is the one-two-thousandth of an inch (Fig. 3). It is composed of eleven segments or petals These petals, in their natural position, seem to perform the office of valves. This orifice is the commencement of the vas deferens, which lines the interior of the mucous gland, and, passing out at the posterior of the same, continues its course for a short distance in a straight line, and then takes on a spiral form,* whose end straightens out and enters the bursa copulatrix by the ligamentous tissue that binds the bursæ together at their lower extremity.

The bursa copulatrix in *Cypris cinerea* is a clasper- or pincer-like arrangement; the chelate ends resemble the claws of the first pair of the thoracic members of the lobster (Fig. 1). It is situated in front of the post-abdominal rami, and, like the mucous glands, lies in apposition, with its chelate ends pointing towards the posterior portion of the body of the creature. It is composed of chitine, and resists the action of liquor potassæ, yet the alkali differentiates its structure and facilitates the tracing of the intromittent organ.

The spermatozoa, when it enters the bursa, does not go direct to the intromittent organ, but ascends up the curved side of the bursa, turns on itself, and passes through an arched, chitinous canal, and then passes into the intromittent organ, so that when conjugation takes place, which it does on the ventral side, the male anchors itself by the hooked palpus of the second maxilla; then, bending its body down until the claws are close under the vulva, in which position they take a firm hold of the female. This act brings the double intromittent organ in close connection with the double vagina of the female, and causes the emission of the spermatozoa into the receptaculum of the female. The length of the bursa from tip of chela to base is from the one-hundred-and-sixtieth to the one-hundred-and-seventy-sixth of an inch, its greatest width, the one-four-hundredth of an inch. By

* The homologue of this is the vasa efferentia in the female.

this it will be seen that the bursa copulatrix of *Cypris* is the reverse of *Cypridina Mediterranea.**

Intromittent organ (Fig. 1, *c*).—This is a paired organ, and is situated nearly in the centre of the bursa, close under the arches, which receive and carry the spermatozoa previous to its entrance into this organ (Fig. 1, *b*). It is a dropsical-looking organ, and may be divided into two parts: the posterior and the anterior portions. The former is an ovoid body, its upper end being the broadest, and receives the spermatozoa from the canals. Its downward course is somewhat diagonal, tending towards the base of the bursa. The lower end, where it joins the anterior portion, forms a kind of elbow. There it makes a junction with the anterior half, which continues its course in a transverse direction towards the flattened edge of the bursa. The intromittent organ has no nodule, but the termination is somewhat bulbous. Its edges lap over and form a wide, circular orifice, through which the spermatozoa passes. Its length is one-thousandth of an inch and diameter one-two-thousandth of an inch.

The Spermatozoa.—With respect to the spermatozoa, Mr. Hervey, F.C.S., and myself spent much time, and jointly made some careful investigations in connection with it. It is but fair to state that part of our time was spent in investigating that of *C. minuta*, and as the histology of one, and more especially as touching the question of mobility, is but the counterpart of the other, I prefer giving an account of our researches under this heading. Professor Huxley, quoting Zenkier, says that "the spermatozoa is totally deprived of mobility."† If by *mobility* we are to understand *active movement*, then we join issue and say that, according to our investigations, this statement is incorrect. It is immaterial whether we take the spermatozoa as it exists in the male, or after its injection into the spermatheca of the female. The result is the same—viz., that it possesses very active properties. In dissecting the animal I use a suture needle with a flat back, and with this, under a dissecting microscope, I gently crush the *Cypris* just enough to crack the shell. Then with fine pointed needles I tear

* See Clans. Ostracoda, p. 425, Fig. 336, Sedgwick's translation.

† "Anatomy of Invertebrata," page 252.

away the carapace, leaving the body of the creature as bare as it is possible to be. I then tease out the spermathecæ, but cannot always succeed in extracting them whole. The spermathecæ are paired organs, somewhat pear-shaped, the membranous tunic being capable of great distension, yet when empty, in consequence of the spermatozoa being used up, become very atrophied—in fact, almost obliterated. They are difficult to preserve. I have, however, succeeded in mounting them in glycerine, after being emptied of spermatozoa by pressure (Fig. 8). When the spermatheca is filled with spermatozoa, it resembles an old-fashioned ball of cotton, the zooids crossing and re-crossing each other. If a cover-glass be placed gently over them so as not to crush or rupture the tunic, we are able, with a one-eighth inch, to see the mass of spermatozoa in a state of agitation, writhing like innumerable microscopic worms. It was at this stage that we commenced jointly our investigations as to their mobility. As has been remarked above, the spermatozoa within the spermatheca was teeming with life, and those in the neighbourhood of the spermathecal aperture exhibited the same vibratory motion. Having satisfied ourselves of their vitality and activity *en masse*, it became necessary to examine them externally and individually. I gently rolled the cover-glass with a needle. This had the desired effect, and the spermatozoa, starting out from the fissure like a number of *Gordiidæ*, kept up an active, wriggling, writhing motion. One fine fellow pushed its way out like a gigantic loop, and kept up a constant action of twisting and untwisting itself. This twining and untwining action cannot be otherwise than an "active mobile existence." When a spermatozoon emerges intact, I have invariably noticed that one end, which I called the posterior end, was hooked; the other has four or five turns, like a drawn-out corkscrew, which I call the anterior end (Fig. 4, *a*, *b*).*

* My reason for applying the terms anterior and posterior is because I have extracted ova with the spermatozoa attached to the ovum. The corkscrew end had entered the micropyle, leaving the hooked end protruding. The zoon had emptied itself of the sperm, was transparent, markings of the coat had faded, and air-globules had entered the empty sheath. These air-globules may have entered the sheath after extraction of ovum from the ovary, and as it lay in the fluid on the glass plate of the dissecting instrument.

Whilst intently regarding the agitated mass which had been set free, we saw one of the hooked ends protrude and gradually draw itself out from the rest with an extended spiral motion, such as I had never witnessed before. This process was very gradual, and at last stopped. It then began to withdraw itself, until, arriving at a certain stage in its backward progress, it again stopped, paused, and then began to move forwards again. I had been using a quarter-inch. This I changed for a one-eighth, and again watched its backward and forward movements, which kept on for twenty minutes. The motion was in a spiral direction, and the hooked end seemed to agitate the fluid in its neighbourhood. Previous to this, it had been no uncommon thing to see portions of the carapace drawn towards them. I am unable to say whether this action was caused by capillary attraction, or by the presence of ciliate processes at present unseen by us. These portions of the carapace became impaled at the end, and were spun round with great velocity. This is remarkable when we consider the disparity of size.

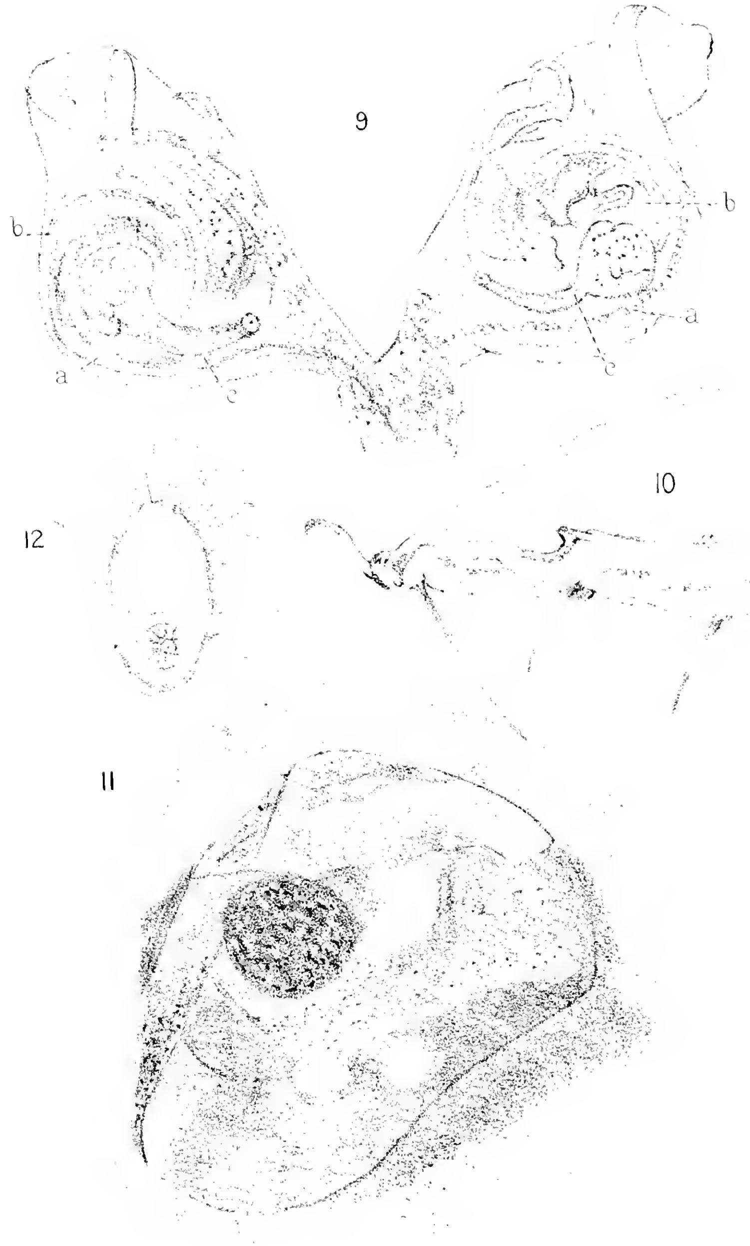
We thought we should like to trace the spermatozoa down the efferent ducts. I therefore extracted the spermatheca with the duct attached. These zooids were a lively lot, and we had no difficulty in tracing the vibratory motion to the base of the spermatheca—spermathecal-aperture—and a short way down the duct, when it was lost to view. I then extracted some of the zooids from the duct. We found that a bundle of zooids of various sizes passed down the duct. I extracted two in their entirety—viz., with their hooked and corkscrew terminations. These I covered with a cover-glass, adding distilled water, and thus was enabled to time the length of their vitality as one hour and ten minutes, after which time all motion ceased.

The spermatozoons are the carriers of the sperm. In immature specimens the sperm can be seen within the sheath. The length of a spermatozoon barely exceeds the one-fortieth of an inch. If fresh, broken spermatozoa be examined with a one-sixteenth immersion, it will be seen that sperm will escape by emission, or it will protrude. If the former, it has a tendency to run or frill off at the point where it is broken. If the latter, we find a thin, membranous substance enclosing the sperm lining the

narrow circular tube within the hard coating of the zoon. I use the expression, "hard coating of the zoon," because its power of resistance to disintegrating influences is very great. It is only amenable to liquor potassæ after long maceration, but its behaviour in the digestive organs of other aquatic animals is interesting. I fed young newts with *C. minuta* and *C. cinerea*, and after a few days' feeding I killed the newts and extracted the viscera. The shelly substance of some of the *Cypris* was unaffected, but those which were near the rectum were soft and pulpy and the viscera partially digested, but the spermatheca was intact and the spermatozoa active. In other newts that I fed, some of the *Cypris* were enabled to resist the gastric juices that are poured into the alimentary canal and to pass, *per anum*, alive. I have taken them out of the rectum of a newt, placed them in water in a watch-glass, and they have been none the worse for their Jonah-like experience. For four days I fed some Sticklebacks with *C. minuta*, and on the fourth day I opened them to see results. The greater number of the *Cypris* were lying in the intestine, dead but undigested. Those which were in the œsophagus, when placed in water, recovered their vitality. I examined some of the dead specimens. The spermatheca was intact, but the spermatozoa, as a body, had lost their mobility, except in one case, which was close to the pylorus. They had preserved their vitality, although the *Cypris* was dead. I also found one specimen of *Cypris*, whose viscera had been entirely absorbed, leaving the spermatheca, filled with spermatozoa, intact in the interior of the valves. The valves were in a very pulpy condition. These I mounted in glycerine (Fig. 11), to show the density of their structure and capability of resisting the absorbing and disintegrating influence of the gastric juices.

CYPRIS MINUTA (Brady), Figs. 9 and 10.—In adding a drawing of the bursa-copulatrix and second foot of *C. minuta*, I do so because Brady frankly admits that he has never seen a perfect specimen of the male of this creature. This is, I presume, because it is somewhat rare in English ponds. I found it to be very plentiful in a low-lying pond in this district, which is full in the winter, but quite dry in the summer (from the month of October last year to January of this year), after which time I

Organs of Cypris



Ovaries of Cypris

failed to find it. I have come to the conclusion that this is the copulatory season, as during this time the spermatophore is filled with spermatozoa. My stock-bottle, which I filled last December, still contains some male specimens of *C. minuta*, but at those intervals when the pond was frozen over, or during the summer months when it was dry, I have drawn specimens from my stock-bottle for investigation, and have found them not exactly destitute of spermatozoa, but inert and in a very morbid condition.

What has been said above of *C. cinerea* with regard to the position of the generative organs and the mucous glands applies also to *C. minuta*. It will be seen, on reference to Plates XXII. and XXIII., Figs. 1 and 9, that the chelæ are much broader and more transparent in *C. minuta* than in *C. cinerea*. The bursæ are smaller, being about the one-two-hundred-and-eighty-sixth of an inch long and the one-four-hundredth of an inch broad. The intromittent organ is placed a little farther back and lower down in the bursa. It is somewhat globular at the posterior end, but has no elbow. As it descends, it takes a sharp curve round the base of the bursa until its termination points towards the flat edge of that organ. It terminates in a nodule, and has a fairly-wide aperture. I have traced the spermatozoa from the arched canal down the intromittent organ. Its length is one-eight-hundred-and-thirtieth of an inch and diameter one-three-thousand-three-hundredth of an inch. On the second foot we get a different formation of the central setæ to that given by Brady. That the spur-like formation is the more accurate will be seen on reference to Fig. 10. I have always found the carapace to be hispid and the second maxilla chelate. It is twenty-three years since Brady added *C. cinerea* as a new species to his monograph, and since then until now it appears to have escaped detection.

EXPLANATION OF PLATES XXII. and XXIII.

Fig. 1.—*Cypris cinerea*, bursa-copulatrix :—*a*, spermatozoa ; *b*, arched canal ; *c*, intromittent organ ; × 595 diam.

,, 3.—*Cypris cinerea* :—Stoma of same, × 2,000. diam.

,, 4.—Ditto, spermatozoa :—*a*, anterior ; *b*, posterior ; 1/16th inch immersion.

Fig. 5.—*Cypris cinerea* :—Plumose seta, second antenna, × 595 diam.
,, 6.—Ditto, second foot male, $\frac{1}{6}$th of an inch, Zeiss.
,, 7.—Ditto, ,, ,, female, ,, ,,
,, 8.—Ditto, female empty receptaculum-semines, $\frac{1}{6}$th inch, Zeiss.
,, 9.—*Cypris minuta*, male, bursa copulatrix, letters same as in Fig. 1, × 595 diam.
,, 10.—*Cypris minuta*, male, second foot, × 595 diam.
,, 11.—Ditto, taken from intestine of a Stickleback after the viscera has been digested, × 155 diam.
,, 12.—*Cypris cinerea* :—Anterior end of mucous glandulosa, showing stoma, × 595 diam.

Pseudo-Helminths: Points in the Natural History of a Nematode Worm.

By Jabez Hogg, F.R.M.S., M.R.C.S., etc.

In my paper on "The Embryo of a Parasitic Entozoa," in the *Journal of Microscopy and Natural Science*, July, by a slip of the pen, the measurement of the embryo, as given on page 172, is, I find, somewhat over-estimated. I had, in fact, forgotten for the moment that I was viewing it under a somewhat low magnifying power. A few lines further on I would also ask the readers of the Journal to substitute the word "epithelial" for "tesselated." I should be glad, at the same time, to avail myself of the opportunity to offer a few remarks on several communications with which I have been favoured on the interesting question of spurious parasites, or, as they are designated by writers on this branch of natural history, "pseudo-helminths," the greater part of which have no relation whatever to the animal kingdom.

First, let me say, once and for all, that with regard to henbane seeds, as a remedy in toothache, I have had no personal experience of its efficacy, and can offer no opinion; but more than one of my correspondents furnish me with confirmatory evidence on this point. Dr. Ringwood, for instance, says:—"I have known cases where, though the teeth were bad, but free from pain, henbane-seed inhalations have been followed by the expulsion of

several parasites." On the other hand, a dentist of considerable experience writes me :—"I have seen parasites drop from the mouths of patients on the bare application of hot water and by steaming the mouth." I need hardly say that such testimony might have proved of more value had these bodies been examined under the microscope and classified.

I am well aware of the fact, however, that the seeds of the henbane plant do furnish us at times with a spurious body which may be mistaken for a "worm" or parasite. Those of my readers curious in these matters may easily satisfy themselves of this fact by taking the seeds and subjecting them to the action of heat and moisture. The testa will be seen to swell out, force open the micropyle, and the radicle, or embryo, with one end charred by the heat, shoots out and completes the illusion. But this spurious worm or maggot is large enough to be seen by the naked eye, and is, I think, hardly likely to deceive a skilled observer. There are, however, a very considerable number of other bodies, which have been described as worms or parasites, as, *e.g.*, shreds of blood and tissue detached from the gums and sides of the mouth by the hot fomentations; small fragments of vegetable, and even of mineral substances. A typical illustration of the latter is furnished by one of my correspondents. "If," he writes, "a tooth be broken on extraction after acute toothache, the sphacelated pulp will often be seen to occupy the nerve-cavity and root-canals. It forms an ashy grey, tapering, thread-like structure, not unlike a worm in shape, and it is just possible that it may assume the appearance of a worm and have been mistaken for one."

Among vegetable matters, those more frequently mistaken for worms or parasites are shreds of fibro-cellular tissue, awns of grasses, pith, the carpellary segment of the orange, and, as Dr. Fraser reminds me, "a cleverly-cut fragment of a sod of earth, and small pieces of the vascular bundle of a fern." "I have seen," he says, "these and other substances palmed off on my patients by a notorious impostor, a reputed tooth-ache curer, who trades upon the credulity of those who are ready to believe in Faith-healing."

With regard to the specimen which I brought to the notice of

the readers of this Journal in July, I ought to say, perhaps, that my task was a simple one—that of verification, or, more properly speaking, classification. But a professional friend and naturalist tempts me into a byepath of speculation. He insinuatingly writes:—"Would it not find a more fitting place among NEMATODA, and probably be *Filaria bronchialis?*" My reply is that it certainly belongs to the TREMATODA, although it bears a close resemblance to the male *Sclerostoma syngamus*, a nematode entozoon, better known under the name of the Gape-worm, a parasite not only more widely distributed, but is invested with a special general interest from the fact that it is the cause of the gape-disease among chickens, pheasants, partridges, magpies, hooded crows, starlings, swifts, and many other birds. There is an undoubted family likeness, however, among the embryos of all the genera of entozoa. The first stage of their existence and development is passed in the water and as free swimmers, quite irrespective of whether their final destination be *Rediæ* or *Cercariæ*.

In the cause of suffering humanity, it is quite worth while to pursue the morphology of these pests somewhat further. There is yet so much to learn regarding them and their several stages of existence, the more intimate relations which obtain between their embryos and their intermediary hosts, and the extent of the pathological conditions to which they sooner or later give rise in the animal body. We are quite unable to guess by what instinctive agency they are enabled to discover and select the most appropriate resting-place in the interior of this or that animal, and whereby they are enabled to attain to a higher state of organisation. Nothing can strike us with more astonishment than that the Gape-worm, *Sclerostoma syngamus*, should select and find its way, not to the œsophagus, but to the windpipe of the chicken or bird, and thus subject its host to a cruel death by suffocation. It seems to be bent upon propagating its species at the cost of life to the higher orders of creation. With reference to internal parasites as a whole, although certain districts are known to have special attractions for many of them, yet none seem to have an abiding resting-place. On the contrary, all have a disposition to roam over a wide area, and it is in this way they so thoroughly

succeed in baffling the scientific acumen of the skilled Helminthologist.

For the reasons stated, even small and apparently isolated facts are often of some importance. Now, I have lately had the advantage of making myself fully acquainted with the "Gape-worm" by a careful examination, and after removal by my own hand of innumerable specimens from the windpipe of the young pheasant, and I trust the observations I am about to offer may prove acceptable to the student of natural history. I may point out, first, the great disparity observed in the size of the sexes. The female of the genus *Sclerostoma syngamus* measures full six-eighths of an inch in length, while the male scarcely exceeds the one-eighth of an inch. On detaching the female from the trachea of the bird, and of which she had still a very firm hold, she was of a deep-red colour, at first sight very like the smaller blood-worm of the Thames, *Gordius aquaticus*, and for which, when taken out of the windpipe, she might easily have been mistaken. The male worm, from its minuteness and want of colour, was at first quite overlooked by me, but on a more careful search, and by the aid of a pocket-lens, was at length discovered attached to the upper fourth of the body of the female. The remarkable tenacity of life displayed by these parasites I must not pass over without notice, as on the third day after the death of the bird I found, on cutting open the windpipe, the whole of the females alive and vigorous, and so they remained for twenty-four hours, although immersed in water and exposed to the light.

With reference to their morphology, the integumentary covering of the body is uniformly smooth throughout, and about the upper portion of the epidermis an irregular epithelial pigmentary layer can be made out. Beneath this is the denser cutis, and then a broad band of longitudinal and transverse muscular fibres, which under a high power bear a striking resemblance to the striped muscle of the Vertebrata. The most internal basement membrane consists of a delicate mucous coat and a layer of tesselated epithelium. The digestive and cœcal canal of the female is seen to terminate in a sharply-pointed anal opening, which also serves as an ovipositor. The terminal portion of the male differs very considerably. It is truncated and

rounded off, turns sharply on itself to form a clift and an opening, in which are placed the organs of generation.

The nervous system is quite of an elementary nature. So far as I can discover, it consists of a single cephalic ganglion, which sends off one or more minute branches to the proboscis or oral opening. Organs of special sense are entirely wanting. There is nothing remarkable about the mouth. It is formed for suctorial purposes only. In form and structure it is perfectly circular, and is divided into two or three rings, which are acted upon by separate sets of circular and radial muscular fibres. The inner or middle ring, when opened out, divides into six equal parts, which turn outwards upon the inner lip, somewhat like the petals of certain flowers. The muscular layer is capable, when set in action, of producing a considerable vacuum, while the radial set will convert the innermost disc into a sphincter, closing up the œsophageal opening. The oral arrangement of the male appears to me to differ slightly. I make out a third inner divided disc, with a series of equally disposed chitinous teeth.

Dr. Cobbold, in his valuable work on "Entozoa," in a woodcut drawing of the female, represents the disc I allude to, but this is an error on his part, for this is only seen in the male. The vulva and uterus of the female is located unusually high up in the body, and here the male is securely attached. In this case it is the female who shows herself an imperious monogamist, for having selected a mate she compels him to cling to her body, and thus carries him about with her for the rest of her natural life. It has long been in dispute whether or not actual incorporation of substances takes place between the sexes. Von Seibold taught that there is actual incorporation, but I believe this is quite a mistaken view, founded, of course, on the very intimate nature of the connection, although the same kind of joining of the sexes is seen to take place in certain of the Lepidoptera—the silkworm moth, for instance.

The male organ of generation is of a very distinctive character. It consists of a double set of trifurcate, finger-like series of processes, and an intermediate tripartite penis. These several parts, on passing through the vulva, have an antagonistic action to the other. I have been unable to satisfy myself of the existence

of any cup-shaped appendage formed out of a folded extension of the dermal covering, described by Dr. Cobbold, and which, he says, consists of "a membranous bursa, strengthened internally by a series of projecting rays, intended for the purpose of fixing and supporting it in the same manner as we find the whalebone rods employed to distend the hood of the umbrella."

The ova sac is tortuous and convoluted, and extends throughout the length of the body. It is literally loaded with eggs in all stages of development, and numbering from one to two or three thousand. The egg, as first seen, is a mere globular speck of protoplasm, but after fertilisation takes place the mass breaks up, the nuclei enlarge, and segmentation of the whole quickly follows. At the same time the egg becomes ovoid in shape, with a lid or micropyle at one end, and through which the young worm emerges at maturity. When first hatched, the embryo is without structure. It is little more than a contractile integument, enclosing innumerable granular bodies, no distinctive or formed organs being visible. Notwithstanding, it is quite equal to an active migration, and probably will next be met with in the body of one of the smaller *Pulmonata*, or attached to a portion of decaying vegetable substance, and ultimately finding its way to a pond or stream of water. Evidence is certainly wanting in confirmation of the statement made that it enters the body of the common earthworm. In what way it really gains access to its intermediary host remains a mystery. There is, however, no doubt whatever of its extraordinary breeding powers and great tenacity of life.

Should a single worm enter the windpipe of one of the feathered tribe, it quickly proves itself a bloodthirsty foe. I have seen the trachea of a young chicken swarming with Gape-worms, and I have been led to wonder how breathing was sustained and life prolonged.

I conclude with a word of warning, because I have been given to understand that in some agricultural districts it is no uncommon thing for the poor people to cook and eat poultry and game dying or killed from gape-disease. The head and neck is perhaps severed from the body and carelessly thrown out into the dust-heap, to be pecked at and eaten, and so to infect other birds and animals, a prolific source of spreading a loathsome and noxious

disease. It is, therefore, of the utmost importance that the bodies of birds dying from "Gapes" should be burnt—*cremated*—as soon as possible after death. By taking a precaution of this kind, and by paying greater attention to the hygiene of the poultry-yard, this terrible *Strongulus* may be prevented from slaying annually its thousands of victims.

Instantaneous Mounting in Farrant's Gum and Glycerine Medium.

By R. H. Ward, M.D., Troy, New York.

TOO much can scarcely be said in favour of Farrant's Gum and Glycerine Medium* for facility of use. It may be inferior to glycerine jelly for mounting sections that are large and not liable to be injured by heating, as both it and that are doubtless inferior to Canada balsam for objects that are not too transparent in the latter, or that can be rendered sufficiently conspicuous by staining, and that can be dehydrated and transferred to the balsam without injurious modification of structure. But it answers excellently for a very large variety of specimens, both animal and vegetable, that can be studied to advantage in water or in glycerine, and that, in the former case, can be transferred to a dense mucilaginous medium without destruction by exosmose. For such objects it very nearly accomplishes the paradox of enabling one to mount specimens without the trouble of mounting them.

Those who prepare objects for the trade, and students who are working in the laboratories as learners, make a business of the hardening of objects, the cutting of sections, the handling of

* Farrant's medium is prepared as follows :—

Picked gum Arabic	...	... 4	parts	by weight.
Distilled water (cold)	...	... 4	,,	,,
Glycerine	...	... 2	,,	,,

Keep in a glass-stoppered bottle, in which should be put a small piece of camphor.

re-agents, the selection and manipulation of varnishes, etc.; and many amateurs and even professional admirers take pleasure in imitating, and often excelling, them in this recreative work.

Many professional microscopists, however, find their time filled with other engagements. Objects almost without number are examined for purely scientific investigation, or for sanitary, economic, medical, or legal purposes, and then are inevitably thrown away for want of the time required, but not just then available, for mounting them. Such objects are often examined in glycerine; and proving interesting, they are laid aside unsealed only to be found spoiled when next seen, or are ringed with varnish, without a cell, to make a mount that will be short-lived by reason of the running-in or splitting-off of the cement. It is no more trouble to place such objects, and cover them, in the gum and glycerine medium at first, than in plain glycerine; and then they are already mounted to begin with, and they can, as desired, be washed off the next day, or be neglected for years without injury.

The following points may be of use to those not accustomed to this instantaneous method of mounting:—

1.—Use only sufficient of the medium. By a little care a drop of the right size can be employed, so that the cover-glass will be supported to the edges, but without enough surplus material to require the fussy procedure of cleaning off the excess. If any should require removal, leave it to be scraped off with a knife after drying for a few hours, instead of washing it off at once with water.

2.—Breathe on the slide, and also on the cover-glass, just before making contact with the medium, to moisten the surface, and thereby prevent entanglement of air-bubbles.

3.—Plunge the object into the drop of medium by means of a needle or of a flattened lifter, without entangling air by unnecessary stirring, and remove with the needle point any bubbles that may be seen. Do not discard the specimen if a few small bubbles be included, as they may disappear in time.

4.—The object may be taken from glycerine, or from a watery fluid, or even from diluted alcohol. Do not dry it enough to get air into the tissues; but be careful not to carry too much of the

medium with it, as it is easy to introduce, in this way, enough water to make the medium too thin, or enough glycerine to prevent its drying properly.

5.—Keep, within reach, a bottle of carmine or hæmatoxylin stain, the latter being capable, probably, of most general application; and try immersing in a drop of it, on a slide or in a watch-glass, such objects as are likely to take the stain promptly. Many delicate sections, or membranes, teased-out tissues or fibres, secretions containing interesting physiological or pathological structures, etc., will be stained exquisitely by being dipped in this a few seconds, on the way to the mounting medium, or at most by lying in it while the next object is being examined.

6.—If the object be thin, no care is required after covering; but if thick, air may possibly enter at the side by shrinkage in drying, which should be corrected by keeping the mounts in sight a few days and applying, when required, a small drop of the medium, not over but at one side of the incipient air-bubble, so that it will run in in place of the air.

7.—If the object prove valuable, but not otherwise, label and number it at once, and record in a systematic catalogue anything important that may be known about it.

8.—If properly managed, the slide will need no cleaning after the mounting and labelling are finished. It should only require to lie untouched for a few days while the gum is drying at the edge of the cover-glass.

9.—Any time, after a few weeks, months, or years, the slide may be placed on a turn-table and a ring of shellac varnish or Bell's cement added. This will give a neat amber finish, and may keep the medium from distorting the object or the cover-glass by shrinking too much or from becoming too hard and granular, in case it has been incorrectly prepared or used.

By adopting this method of preserving suitable objects that may come under his examination, the busiest man may, in the course of a few years, prepare a valuable collection, without appreciable labour and almost without knowing that he is doing it.

The Microscope and How to Use it.

By V. A. Latham, F.R.M.S.

Part XV.

Practical Hints on Histology.

Special Methods for Examination of the Spinal Cord, Brain, etc. (*continued.*)

Spinal Cord, Fibres of (Schieffordecker's method).

PLACE a piece of fresh cord, with its membranes removed, for about a month in Müller's solution; then wash for about twenty-four hours with water, and afterwards place in alcohol. Wash the sections in water for one or two days, and stain with palladium chloride or gold chloride. Wash with water, and pass through absolute alcohol and oil of cloves into balsam.

Palladium Chloride.—This agent is used to demonstrate the longitudinal fibres (therefore, longitudinal sections must be cut), a solution of 1—10,000 strength is taken. The sections should remain in it till light brown (about three hours).

Gold Chloride.—Used for transverse sections. Strength, 1 to 5,000 or 10,000; time, 1 to 3 hours. Wash the sections well in water, and place in acetic acid, $\frac{1}{2}$ to 1 per cent., for twenty-four hours. Then mount as described above.

Picro-Carminate of Soda and Palladium Chloride.—Place the sections for one to three minutes in a 1 to 300 or 600 solution of palladium; rinse in water; throw for eight to ten minutes into a cold saturated solution of picro-carminate of soda. Mount in dammar.

Staining Isolated Ganglion Cells.—Macerate small pieces in a small quantity (just sufficient to cover them) of Ranvier's alcohol for several days. Take some small fragments of grey matter, and well shake them in a test-tube with a little water. Then add a little glycerine and a few drops of the concentrated solution of picro-carminate of soda, and set the whole aside for one or two days. Decant, and to the red deposit, which is now composed of stained ganglion-cells, add one or two drops of glycerine, and

place the whole for two days in a dessicator, with sulphuric acid. (This is best done in a watch-glass or flat-bottomed cell.) The cells are best got on to the slide by pouring a drop of the dehydrated glycerine on to it.

Aniline Blue for Processes of Ganglion Cells.—Take sections of cord or brain that have been hardened in bichromate; wash with acidulated water, stained, *in the dark*, in a slightly acidulated hydrochloric or acetic acid solution of the soluble aniline blue of commerce. Wash out with acidulated water, rinse quickly with absolute alcohol, clear *in the dark* with creosote, and mount in dammar. N.B.—Do not allow them to remain in the creosote long, and they must be preserved permanently in the dark.

Carriere's Method * for Ganglion Cells.—Put fresh sections of cord into the three following solutions:—(*a*) Bichromate of potash, 1:600; (*b*) bichromate of potash, 1:500; (*c*) chromate of ammonia, 1:600. After ten days remove sections from *a* and *b*, wash with water, throw into barely transparent ammoniacal solution of carmine. Five days afterwards the sections from *a* were easily teased out; in seven to ten days those from *b*; those from *c* were removed after fourteen days into the carmine solution; and after three days tease them. By these solutions the anastomoses between cells of anterior cornea may be demonstrated.

Weigert's Method for Central Nervous System †.—Stain the sections, hardened in Müller's fluid or bichromate of potash, for twenty-four hours in a concentrated watery solution of acid fuchsin (soda-salt of rose-aniline sulphate). Wash in water, and transfer to an alkaline solution of alcohol—viz., 100 cc. of absolute alcohol with 10 cc. of a solution, made by dissolving 1 gramme of fused caustic potash in 100 cc. of absolute alcohol, and filtering for a few seconds, until the first sign of the grey nerve tissue of the section becomes visible. Wash in water, which must *not* be acid, and dehydrate with absolute alcohol saturated with sodic chloride, to preserve the colour of the section. Clear with oil of cloves, and mount in Canada balsam. The blue tint may be increased by putting the sections in a solution of 1 part of hydro-

* Arch. für Mikr. Anat., xiv. (1877), p. 126.

† Centralblatt f. D. Med. Wissenschaften, 1884, pp. 42—46.

chloric acid to 5 of water, then wash in water, dehydrate with alcohol. I have found it useful in demonstrating the neuroglia cells and processes to stain in carmine; and instead of completely clearing up, treat with methylated spirit instead of absolute alcohol, leave long enough to drive out *only part* of the water; clear up *partly* in clove oil, mount in dammar, and examine at once.

Weigert's Improved Method.*—If sections are to be stained by this method, they should always be hardened by Müllers or Erlitzki's fluids. The latter is made of bichromate of potash, 5 parts; sulphate of copper, 1 part; water, 200 parts; and the time taken is about eight or ten days, and the hardening fluid must not be washed out before placing the piece of tissue in the freezing microtome. The sections should be cut before the pieces have been soaked in water or placed in alcohol for permanent preservation.

Staining.—Make some sections, and always examine them first in a drop of glycerine before staining, if the ordinary stains are desired. If Weigert's method is employed to harden tissue, do *not* wash and imbed in celloidin. Moisten the blade of the knife with alcohol, and place the sections as cut in that fluid. First, immerse the sections in hæmatoxylin fluid, prepared as follows:—Hæmatoxylin, 0·75 to 1 part; alcohol, 10·0 parts; water, 90·0 parts. Boil the mixture, and allow it to stand for some days to "ripen" before being used. The dye may be rendered ready for immediate use by the addition of 1 cc. of a cold, saturated solution of carbonate of lithium to 100 cc.'s of the hæmatoxylin fluid. Place a watch-glass with the sections and solution in a hot-air bath, at a temperature of between 35° and 45° C. The time varies. For spinal cord, one or two hours is sufficient, whilst cerebral tissue often requires twenty-four hours. The tissue is now of a blue or black colour; transfer to the differentiating fluid, which is prepared as follows:—Borax, 2 parts; ferrocyanide of potassium, 2½ parts; water, 100 parts. Soak for from half-an-hour to an hour, or more. The grey substance is now pale yellow or brown, whilst the white matter remains dark blue or black.

* "Fortschritte der Medicin," 1884, Bd. II., Nos. 60, 86, Bd. III., No. 8.

Thoroughly wash in water, not in alcohol, which precipitates the ferro-cyanide solution. Then dehydrate with absolute alcohol, clear by means of xylol or origanum oil. These re-agents do not affect the celloidin. Mount in Canada balsam or dammar.

A slight modification is as follows:—Harden the material in bichromate of potash, follow by alcohol, embed in celloidin, cut sections, and immerse them in a half-saturated acetate of copper solution for twenty-four hours, and then in alcohol for a few minutes. After this put the sections into a solution of hæmatoxylin for twenty-four hours, and wash in water for a few minutes. Then transfer them to a solution of ferro-cyanide of potash till the colour is washed out, except from the medullated fibres. I find this very good for cord of Tabe's dorsalis and brain sections. Some regard the acetate of copper as a hardening agent, which it is not, and if used as such the tissue will be spoilt.

The only drawback to Weigert's method is that sections must be cut and stained immediately after hardening and before transferring to alcohol. If pieces after hardening have been in alcohol so long as to become green (a change which takes place in all chromic acid specimens after being kept in alcohol), the staining will fail. To obviate this, the tissue is subjected to the celloidin process, and fixed on a piece of cork in the usual way. Then place in a beaker, with the saturated acetate of copper solution (as above), diluted with an equal quantity of water, and the whole placed in a hot-air bath, and kept at between 35° to 45° C. for two days; after which cut sections and stain as before. By this method, heating hæmatoxylin is unnecessary while staining, and the differentiating fluid should be diluted with an equal volume of water.

Chloral Hydrate Method.—Harden in Müller, bichromate of potash, or if a faster reaction is required, ammonium bichromate may be used, or a 10 per cent. solution of chloral hydrate. Change after twenty-four hours and again at the end of the third day, and at the end of the first, second, and fourth weeks; after which the cord may be left in the fluid until it is transferred to the gum and syrup solution before the sections are made. Stain and mount as required.

Debore's Method.*—Place in a 4 per cent. solution of bichromate of ammonia for three weeks, then in a solution of phrenic gum for three days, and for three days more in alcohol. Cut sections and place in water to prevent curling; immerse in a saturated solution of picric acid for twenty-four hours, and colour with carmine for about twenty minutes, the picric acid acting as a mordant.

Double Stain for Nervous System.†—Sections—which should not be in water for more than five to ten minutes after cutting—should be placed for several hours in a concentrated watery solution of methylin-blue; wash in water and transfer to a saturated watery solution of acid fuchsin for about five minutes. Quickly wash in water, and place for a few seconds in 1 per cent. alcoholic solution of caustic potash, and wash in a large quantity of water. Gerlach's network of delicate fibres stain blue or violet on red ground.

Prof. Adamkiewicz's Method is to stain with saffranin and methylin-blue when individual segments are to be differentiated and mount as usual for anilins.

Staining Axis Cylinder of Medullated Nerve-Fibres.—Fix the nerve on a cork, and place for two hours in a ½ per cent. solution of osmic acid; wash for two hours in distilled water; stain for twenty-four to twenty-eight hours in a saturated solution of acid fuchsin; wash for six to twelve hours in absolute alcohol, clarified with oil of cloves, imbed in paraffin, and cut.

An excellent method, and one which gives very satisfactory results, is that which is used by Dr. C. Robertson, Demonstrator of Anatomy, Oxford. Place portions of *warm* cord, about 1 in. long, in spirit (10 over proof) from four to five hours; transfer to a 6 per cent. solution of bichromate of potash for six days, care being taken during the process of hardening to remove with a razor thin sections from the ends to allow the solution to thoroughly penetrate to the interior of each piece. Transfer to weak spirit for two days, then to strong for two or three more days, when

* "Archives de Neurolgie."

† "Zeitschr. f. Weis. Mikr.," Vol. II., 1885.

the cord may be kept till wanted for sections. Portions of cord are stained before sections are made by soaking for twelve hours in a solution of good picro-carmine. Wash in weak spirit, and soak for a short time in absolute alcohol, which should be used to wet the razor in cutting. Clear in clove oil, and mount in dammar or Canada balsam dissolved in benzole. This way of staining in picro carmine before cutting enables one to trace the processes, cells, etc. The best picro carmine is made by MM. Rousseau and Son, Paris, or Martindale. The only objection to the ammonium-bichromate method is that the solution is liable to deposit in the form of small specks amongst the nerve.

Spirit and Iodine Mixture and Ammonium Bichromate.—Place the cord in a long glass tube of rectified or methylated spirit, made slightly brownish with tincture of iodine for three or four days, or until the iodine colour has vanished. Cut into pieces about half-an-inch long, and place them in three times their bulk of a 2 per cent. watery solution of ammonium bichromate for four to five weeks, and transfer to spirit until required.

I have found **Dr. H. Gibbe's Double Stain** to show cells, nuclei, etc., well, and it is pleasant to work with.

Beck's New "Purple" stains nuclei well, and brings out minute vessels. It is a slow process, and requires a good deal of washing in spirit, and is therefore not a very handy stain.

Coppock's Magenta and Aniline is a very ready stain, differentiates the several structures, and is easily dehydrated with clove oil.

Anilin Blue Black, according to the depth of tint employed, is good for the differentiation of structure. It brings out well the cells from the neuroglia. It, however, requires care in adjusting the tint.

Judson's Cambridge Blue is a convenient form of stain.

Ink is a very good stain, more especially for the cells of Purkinje in the brain.

Half-an-Hour at the Microscope, With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Phthirius inguinalis (Pl. XVII., upper portion).—The characters which separate *Phthirius* from *Pediculus* are—the fusion of the thorax and abdomen, and the possession of two kinds of limbs, ambulatory and scansorial. It is a very remarkable form of life; the fusion of thorax and abdomen and corresponding union of nerve-centres, would denote it the highest form known among the *anoplura;* but on the other hand, by the possession of rudimentary abdominal limbs (a characteristic unknown in any other example of this natural order), it makes an approach to the lowest form of Arthropoda—the Millipedes and Centipedes.

I know nothing in its way equal to the idea of huge, massive power conveyed by an attentive study of one of the posterior limbs in this creature. Time does not allow of entering fully into it here, and it is the less needful, as the details are carefully given in the Plate, with, for comparison, the corresponding limb from the Hog-Louse, *Hæmotopinus suis.*

As many of our members belong to the medical profession, I think it scarcely needful to apologise for quoting a highly-interesting case of its occurrence in the upper eyelash, from a work to which some of them may not have ready access. For the ability to do this, I am indebted to the kind courtesy of J. F. Streatfield, one of the surgeons to the Royal London Ophthalmic Hospital, Moorfields, and editor (in 1859) of the "Reports." The case is ably reported by Mr. W. W. Harkness:—

"The following case seems worthy of record, both on account of its comparative rareness, and also because opportunity was afforded of accurately determining the nature of the insect infesting the eyelashes. For the very faithful drawings illustrating the case, I am indebted to Mr. Streatfield, amongst whose out-patients it occurred:—

"R. P., æt. 50, a German Jewess, residing in Houndsditch, applied at the Moorfields Hospital, on account of a chronic ophthalmia of the left eye. On examination, the lashes of the *right* upper eyelid were found to be thickly studded with a number of dark-brown, bud-like bodies, of about 1—48th inch in length, and which microscopical examination proved to be the eggs of the *Phthirius*, or *Pediculus pubis.* One or two *Phthirii* were also found half-hidden among the lashes, which were spread and seemed to be kept apart by the numerous ova attached to them. The eyebrow, and when first seen the lower lids, were free

from eggs and insects. The left eyebrow and lashes were also unaffected.

"The patient was not conscious of anything amiss with the *right* eye, and did not appear to suffer any inconvenience from the presence of the insects."

Dalrymple ("Pathology of the Human Eye") mentions his having seen three cases of this complaint in children, and gives a representation of the eyelashes, but not of the insect, although he calls the disease *Phthiriasis*. Wedl ("Grundzüge der Pathologischen Histologie"), in describing the *Phthirius*, says that it is met with in the hair of the pubes, axilla, breast, and eyebrows. I have been unable to find a representation of an insect actually taken from the eyelashes.

"The insect represented in Plate IX., Fig. 2 (a most careful figure, corresponding in every respect to the insect before us, and perfect), was taken from the eyelashes and mounted in glycerine, and will be seen to be a well-marked specimen of the Common Crab-Louse, or *Phthirius*. In Fig. 4 is seen the ordinary appearance of the eggs as seen with a magnifying power of 80 diameters. In Fig. 5 (our Fig. 5) the egg has been rendered transparent by glycerine, and examined with a power of 130; in this the fœtal louse is distinctly seen. The lashes were found to have on them from one to five eggs. The latter are pear-shaped and cemented by their narrow ends to the shafts of the hairs with a transparent cement. The broad end of the egg has a lip, to which is attached a conical lid, studded with little nodular processes. This falls off when the fœtus is fully developed. The egg is lined throughout with a membrane (chorion), which contains the fœtus. The lice were found adhering closely to the cuticle at the roots of the lashes, and considerable force was required to dislodge them.

"On close investigation, the patient was found to have the *Phthirius* in the hair of the pubes, and of the axilla, and the *Pediculus capitis* in that of the head. At a subsequent visit, an egg, resembling those of the *Phthirius*, was found in the right eyebrows, as also a *Phthirius* in the lashes of the right lower lid.

"The particulars of this case clearly illustrate the fact that the louse which infests the eyelashes *is* the *Phthirius*, although the *Pediculus capitis* may exist at the same time in the head.

"The treatment consisted in cutting off the eyelashes as closely as possible and painting the edges of the lids with a strong solution of bichloride of mercury. After two operations the patient reported herself cured." To this the editor appends a note, as follows:—"She only answered by her daughter, and as she did not appear herself again at the hospital the *cure* could not be completed. It is the more unlikely that she will be free from the complaint even in the eyelids, since it has been remarked that

these parasites progress from the pubes to the axilla, and then to the eyelids, always upwards."

Parasite from Flying Fox (Pl. XVIII., Figs. 1 and 2).—This belongs to the *Nycteribiidæ*, the very lowest among the *Diptera*. It is a most anomalous form. I append figures of male and female, to facilitate comparison of the parts in the two sexes. "The second general section of the *Diptera* is composed of small groups of parasitic insects of very peculiar structure, forming the Linnæan genus, HIPPOBOSCA, and differing from the flies composing the former section (*Œstridæ*) in the structure of the mouth, the insertion of the antennæ within the head, and of the latter within the front of the thorax, the denticulation of the tarsal claws, and the nature of their transformations."—Westwood, "*Introduction to Modern Classification of Insects*," Vol. II., p. 580.

We owe much of our knowledge of these singular parasites to Professor Westwood. As usual, he has paid great attention to the parts comprising the mouth, and dismisses the subject as follows:—An extract from Van der Hoeven ("Handbook of Zoology," Vol. I., p. 311) will best precede:—"The bucal organs pass into fine threads through a small opening ('Just like a thread through the eye of a needle' (Westwood)."

They are three in number. "Being of unequal size, and consequently single organs, they cannot represent either mandibles or maxillæ, and must therefore be regarded as the analogues of the labrum, lingua, and labium" (Westwood, *loc. cit.*, p. 582). The determination is, however, acknowledged to be one of extreme difficulty, and there seem to be scarcely sufficient materials as yet whereby to settle the knowledge with sufficient precision. I hope members who may have opportunities of studying bats will pay special attention to their parasites.

On a former occasion, the extraordinary way in which they represent, with the Diptera, the *Ixodidæ* amongst the acari, was pointed out. The fusion in the ♀ of all the abnormal segments beyond the first, to form a spider-like body, strikes me as one of the most singular points about it, the long hairs terminating it even having their counterparts in those which guard the spinnerets of spiders. In the male, as will be seen here, the abdominal segments are as distinct and as moveable as in ordinary flies. "The abdomen" (in *Nycteribia*) "is covered with a continuous membrane, capable of great distension, which occurs in the female, the larvæ hatching and being nourished in that situation until they have assumed the pupa state, when each is deposited in the shape of a soft, white, roundish egg notched at one end, without any trace of articulation, and nearly as large as the abdomen of the parent fly. Subsequently this puparium becomes

hard and dark-coloured, and within this puparium the real pupa is found, and from which the fly escapes by scaling off the notched extremity of the case. Although these insects are furnished with a pair of remarkable ovaries, their progeny consists but of a single pupa, after the exclusion of which the abdomen becomes shrivelled and contracted" (*loc. cit.*, p. 584).

The "curious appendages at apex of thorax," referred to by Dr. Rowe (p. 260), demand attentive consideration :—"They have neither wings nor balancers," says the learned author we have so frequently quoted, "but the intermediate legs are connected at the base with a pair of strong, comb-like organs, which are the probable representatives of wings." And such turns out to be the case! The scales to which these strong, abbreviated bristles are attached are *rudimentary wings!* You will hardly wonder after this to learn that rudimentary balancers are also present, or that "Mr. McLeay has shown me" (Professor Westwood) "species from the West Indies possessing short wings."

When all the forms we can obtain have been round the Society, and the facts they present come to be grouped in series, you will be perhaps better able than now to appreciate the delight with which I studied these parasites of Flying Fox. I was eagerly wishful to see specimens, and they came in answer to the unuttered wish. The "quaint zone of processes" is simply an excessive development of strong hairs present at the free edge of the first abdominal segment in ordinary flies. Another very remarkable point is the division of the femur into two portions, of the tibia into three, of the basal joint of the tarsus into numerous articulations (twenty-five). This "vegetative repetition," as Professor Owen has aptly termed similar conditions, is paralleled in *Phalangium*, the long-limbed autumnal spider, or "Harvestman." The form of the claws is, as the contributor has well expressed it, wonderfully adapted for *clinging* to its victim. In thinking over the claws of other clinging creatures by way of instituting a comparison, it occurred to me, "Why, that's wonderfully like the claws of sloths, that spend all their lives hanging to the branches of trees," and the claws of the flea, that hang on to our skin so vivaciously, and the claws of *Melophagus*, and so on. But it would take a long paper to describe all worthy of note in this interesting creature.

Melophagus ovinus, Sheep-Tick (Pl. XVII., Fig. 6) will be fully described in the explanation of that Plate.

Wing of House-Fly is from *Musca domestica*, the smaller house-fly. It looks like the work of a beginner, who deserves genuine praise for giving his attention to the natural objects whereby he is surrounded. If we keep that steadily in view, we

shall be astonished to find how much may be learnt with little trouble. Nay, I will put it more strongly, and say, How much is constantly passing before us, calculated to make the most prosaic life one of unceasing interest! I have been running over the list of natural orders of insects in Westwood, and find, as I thought, that from the windows alone of my house in the country, examples of every order, from the highest to the lowest, of very many genera, and of a large number of species have been procured.

The *entire* wing should always be mounted, which is best done by cutting it out carefully with a handled needle (see Pl. XVII., Fig. 7), ground down on a hone, to make a cutting-instrument. The fly being held in the left hand, and a watchmaker's eye-glass used, the work to be done may be clearly seen. There is attached to the base of the wings, behind, a pair of small membranous appendages, termed alulæ, or winglets, of a whitish colour. And they are best displayed when mounted *dry*, with the free end of the wing pointing to the left hand, the direction whence the light comes. The lovely iridescent hues thus obtained make it a splendid object, and the "ridge and furrow" arrangement of the membrane, to secure the utmost effect when beating the air in flight, is very beautiful and deserving most thoughtful study.

Batrachospermum moniliforme (Pl. XXIV., Figs. 1, 2, 3) was preserved in prime condition, and the different parts are well and clearly seen.

Hairs on Frond of Elk's Horn Fern (Pl. XXIV., Figs. 4, 5).—Though the form of the hairs is stellate on both surfaces, a marked distinction will be seen between those seated on the front and back of the frond respectively. The former are few in number, scattered, with mostly eight long-drawn-out rays. The latter form a dense pile, packed as closely as they well can be. The rays are more numerous, varying in number from ten to thirteen, and are also shorter and stouter. There can be no doubt these differences are connected with the relative amount of exposure to light, heat, and moisture of the two surfaces. It will be interesting to note the character of plant-hairs on the opposed surfaces of leaves at every opportunity in this connection. Corresponding differences to those here observed are well marked in *Deutzia scabra* and the Mealy Guelder Rose.

A Law to make the destruction of barberry bushes obligatory in France, Spain, Italy, and Switzerland, except for ornamental purposes in gardens and parks, on account of the *æcidium* promoting the increase of wheat-rust, is being urged by the French National Society of Agriculture.

Selected Notes from the Society's Note-Books.

Parasite of Flying Fox.—This insect being supplied with such claws, two to each foot, scarcely needs the adventitious aid of either of the quaint zones of processes, or the equally curious appendage at apex of thorax. The animal belongs to the *Chiroptera*, of the family *Pteropodæ*, or Rousettes. The term "Fox" is in allusion to the dog-like form of head. The rough outlines (Pl. XVIII., Fig. 10) gives some idea of the head. They are native of the eastern hemisphere, and are the largest of the bats. The Kalong of Java, *Pteropus edulis*, measures no less than five feet in extent of wing and nearly two in length. They are nocturnal in their habits, and are vegetable feeders. T. Smith-Rowe, M.D.

The Rousette.—In addition to Dr. Rowe's remarks, I have added a rough sketch (Pl. XVIII., Fig. 11) of the skull of the Rousette. In the East Indies, the chase of *Pteropi* forms a frequent amusement of the colonists. The flight of these animals is slow and steady, and capable of long continuance. Their ravages among the delicate oriental fruits occasionally cause much annoyance to the inhabitants of these islands. Bevan Lewis.

EXPLANATION OF PLATES XVI., XVII., XVIII., & XXIV.

Plate XVI.

Upper portion.

Diatoms *in situ*.

Fig. 1.—Cocconeis scutellum.

,, 2.—Synedra superba.

,, 3.—Podosphænia Ehrenbergii.

,, 4.—Rhabdonema arcuatum.

,, 5.—Grammatophora marina.

s.v. ("side view" in the technical sense; sometimes it would be more expressive if called "end view.")

f.v., front view; it is in this view that the cingulum ("connecting membrane") is seen, centre portion; all × 200.

Middle portion.

Several hairs from leaf of *Viburnum lantana* (Mealy Guelder-rose), × 100.

Lower portion.

,, 6.—*Caprella linearis*, ♀, × 8.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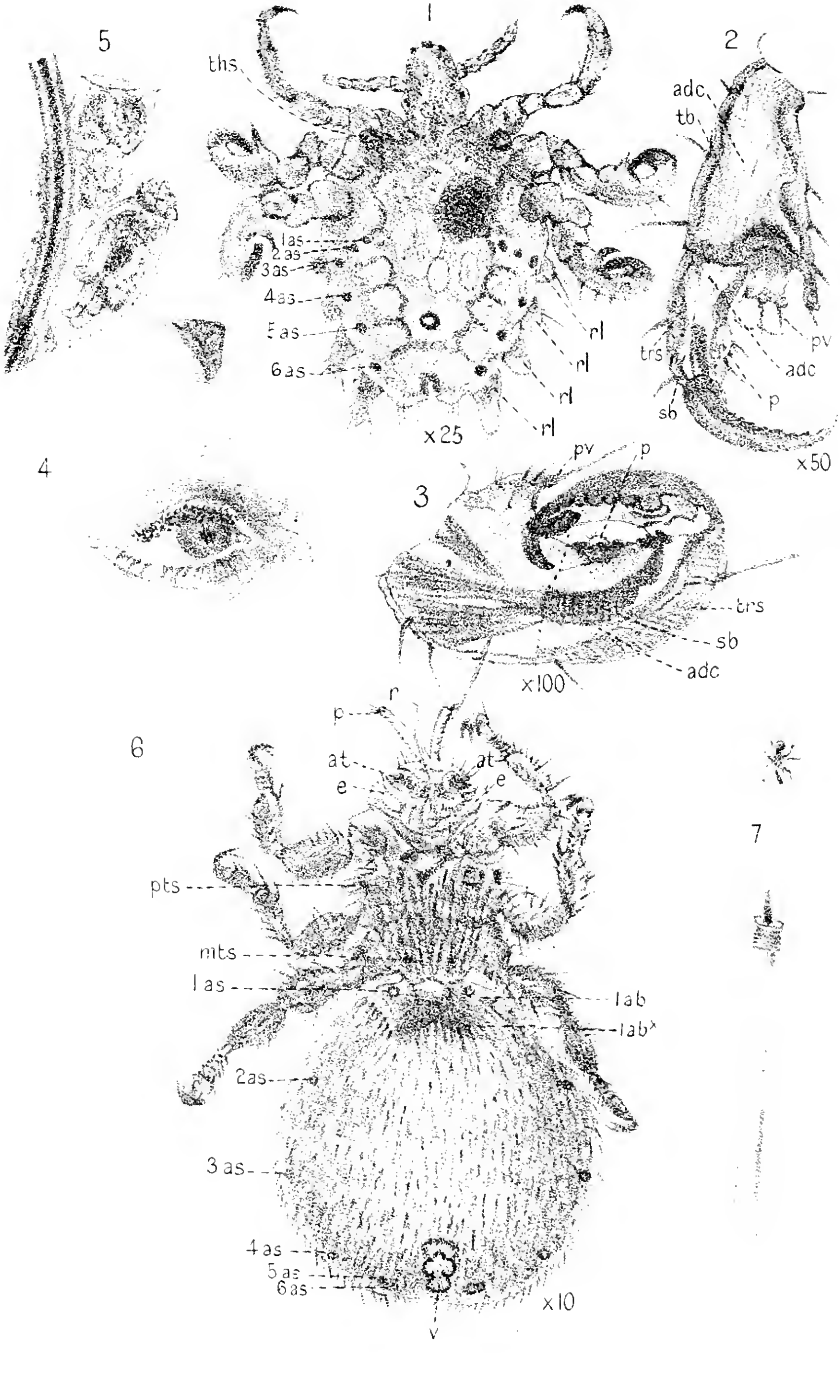

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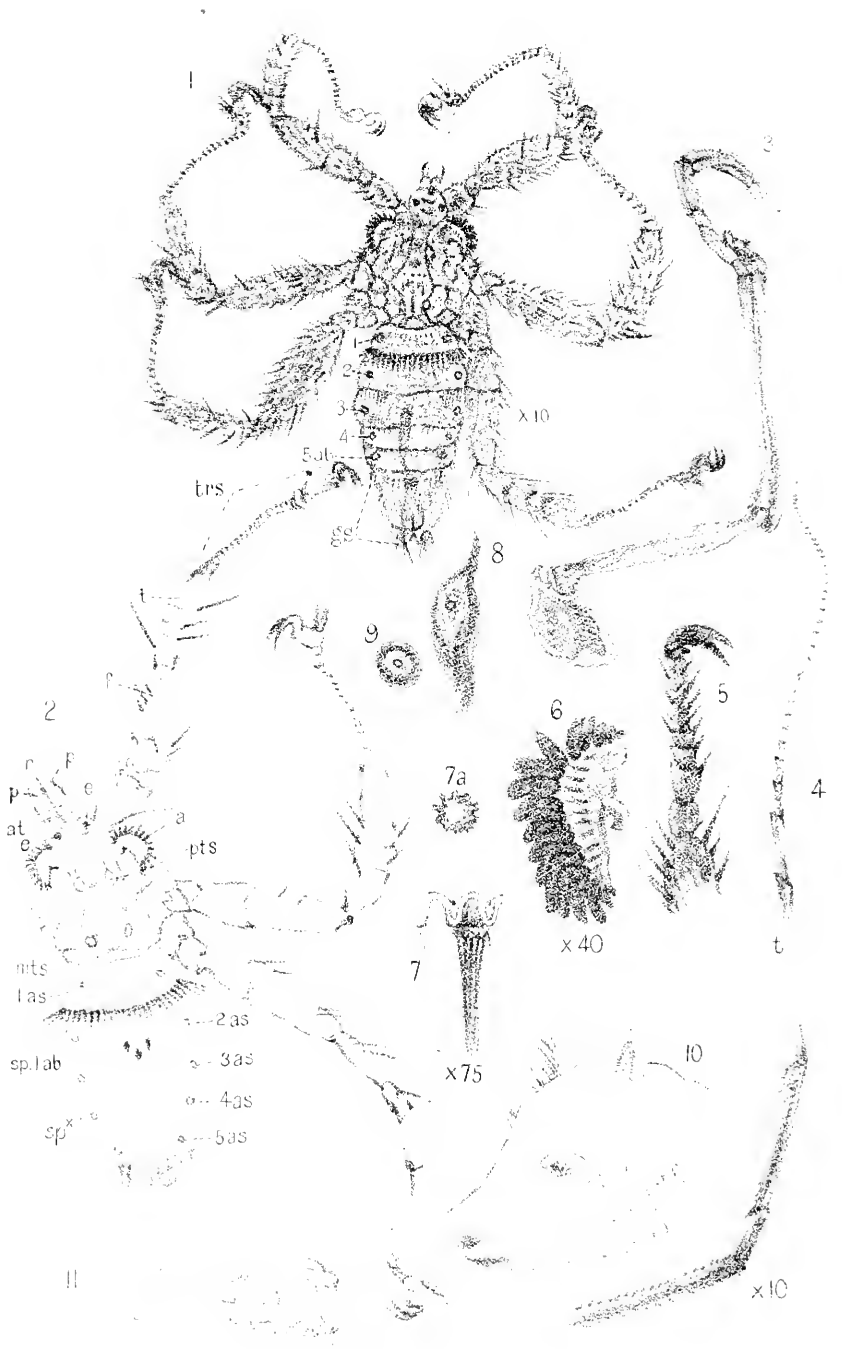
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sp.1ab
sp
7a
6
5
4
x40
t
7
x75
10
11
x10

Plate XVII.

Upper portion.

Fig. 1.—*Phthirius inguinalis*, ♀, 20.

ths., great thoracic spiracle—here apparently prothoracic.
1 *a.s.*, 2 *a.s.*, 3 *a.s.*, 4 *a.s.*, 5 *a.s.*, 6 *a.s.*, spiracles of the 1st to the 6th abdominal segments, respectively, seen through the body, rendered very transparent for the purpose.
r.l., *r.l.*, *r.l.*, *r.l.*, rudimentary abdominal limbs, the true limbs belonging exclusively to the thorax. The position of the stomach, with partly digested food (blood), three immature ova, etc., are also seen. The extremities of the anterior limbs will be seen to differ to a striking degree from those of the posterior limbs.

,, 2.—Termination of second limb, left side, of *Hæmatopinus suis*, posterior aspect, *tb.*, tibia; *trs.*, tarsus, said to be composed of one joint only; *pv.*, pulvillus, (pulvillus, a pillow or cushion). The spongy bodies at the end of a fly's foot are "pulvilli"; *p.*, a soft papilla, bearing two or three hairs; probably a delicate organ of touch; *ad.c.*, *ad.c.*, adductor muscles of the claw; *s.b.*, "sesamoid bone" of the adductor muscle.

,, 3.—Second limb of *Phthirius inguinalis*. The same letters indicate corresponding parts. The dotted line indicates point of fusion of tibia and tarsus.

,, 4.—The eye in Mr. Harkness's case of *Phthiriasis palpebrarum*.

,, 5.—Egg (containing a fœtal louse) and an egg shell (with lid detached, and puckered internal membrane) mounted in glycerine, from the same.

Lower portion.

,, 6.—*Melophagus ovinus*, sheep tick, ♂, seen in the ventral aspect, × 10.

ee., eyes (position of); *at.*, *at.*, position of antennæ; *r.*, rostrum; *pp.*, palpi; *1 ab*, dorsal portion of first abdominal segment; *1 ab* ×, ventral plate of same segment; *v.*, vent and orifice of external organs of generation; *pt.s.*, prothoracic spiracle (position of); *mt.s.*, methoracic spiracle; 1 *a.s.*, 2 *a.s.*, 3 *a.s.*, 4 *a.s.*, 5 *a.s.*, position of the 1st to the 5th abdominal spiracles, respectively; 6 *a.s.*, spiracle of 6th abdominal segment.

,, 7.—Sketch, showing method of using a mounted needle in dissecting a fly.

Plate XVIII.

Fig. 1.—*Nycteribia*, ♂, from Flying Fox.

g.s., genital segments, coalesced.

,, 2.—Outline view of ♀, *Nycteribia*, from Flying Fox. The same letters are used as in figure 6 of preceding plate (sheep tick) to indicate corresponding parts.

a., ala (rudimentary wings); *s.p. 1 a.b.*, strongly developed spines on posterior edge of dorsal plate, 1st abdominal segment; *s.p.* ×, three stout spines a little behind the latter; *f.*, femur; *t.*, tibia; *trs.*, tarsus, divided into five joints.

Fig. 3.—Bones of left fore-limb of a clinging mammal, the two-toed sloth (much reduced).

,, 4.—Second limb, left side, of a species of *Phalangium* ("Harvestman") to show reticulation of tibia (*t.*), as in *Nycteribia*, and "vegetative repetition" of tarsal segments, × 10.

,, 5.—Fore limb, left side, of flea (*Pulex hominis*), in further illustration of curved clinging claws.

,, 6.—Rudimentary ala of *Nycteribia*, with spines.

,, 7.—Two of the dorsal spines of 1st abdominal segment, one in outline only, the other showing fluting, × 75.

,, 7*a*.—Diagrammatic section of spine. (The structure of these spines recalls that of the teeth in the Labyrinthodonts.)

,, 8.—Right prothoracic spiracle, × 50

,, 9.—First abdominal spiracle, × 50

,, 10.—Rough sketch of head of Flying Fox. Drawn by Dr. Rowe.

,, 11.—Sketch of Skull of Rousette. Drawn by Dr. Bevan Lewis.

All the others drawn by Tuffen West.

Plate XXIV.

Fig. 1.—Specimen of *Batrachospermum moniliforme*, natural size.

,, 2.—Piece, × 20, to show general appearance.

,, 3.—Portion, × 150, to show details :—*st.f.*, stem-fibres; *r.f.*, root-fibres, supposed by Berkeley to be analogous in function to the stomata of higher plants. The difference may be expressed as corresponding to that between external gills and internal lungs; *br.f.*, branch-fibres, curiously like the mycelium of fungi; *sp.*, spore.

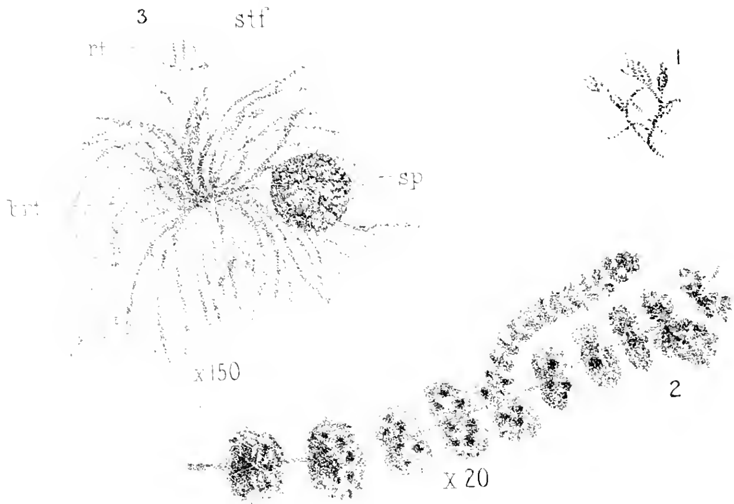
Lower portion of same plate.

Hairs on Upper or Anterior, and Lower or Posterior Surfaces of Frond of Elk's Horn Fern :—

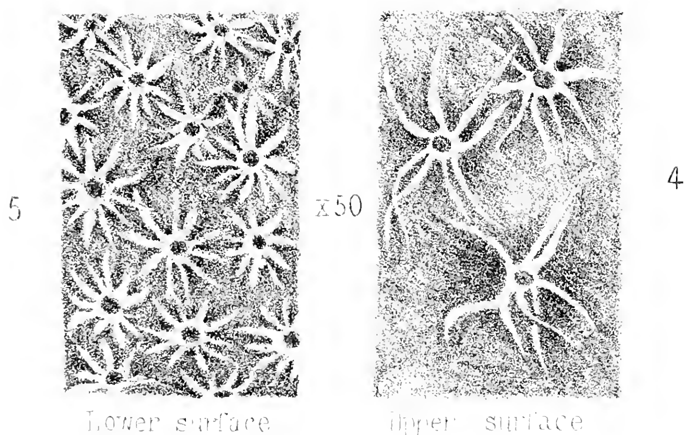
,, 4.—The upper surface, × 50.

,, 5.—The lower surface, × 50.

Drawn by Tuffen West.



Batrachospermum moniliforme



[illegible] Frond of Elks Horn [illegible]

Reviews.

A NEW ENGLISH DICTIONARY ON HISTORICAL PRINCIPLES, founded mainly on the materials collected by the Philological Society, edited by James A. H. Murray, LL.D., President of the Philological Society, with the assistance of many scholars and men of science. Parts 1 to 4, royal 4to, pp. lxii., 1240+152. (Oxford: The Clarendon Press; London: Henry Frowde, Amen Corner.)

Few books which we have noticed have afforded us greater pleasure than has the fine work now before us. We are told that it has been in course of preparation for upwards of a quarter of a century. Its aim is to furnish an adequate account of the meaning, origin, and history of English words, now in general use, or known to have been in use at any time during the last seven hundred years. It endeavours (1) to show, with regard to each individual word, when, how, in what shape, and with what significance, it became English; what development of form and meaning it has since received; which of its uses have in course of time become obsolete, and which still survive; whatever uses have since arisen, by what processes, and when; (2) to illustrate these facts by a series of quotations ranging from the first known occurrence of the word to the latest or down to the present day, the word being thus made to exhibit its own history and meaning; (3) to treat the etymology of each word on the basis of historical fact, and in accordance with the method and results of modern philological science. Different forms, sizes, and styles of type have been employed to facilitate reference, and an illustration with date is given of the use of every word from the 11th century.

The four parts before us cover the whole of A and B, and form Vol. I. of the entire work, whilst the second section of part 4 commences the 2nd Vol. with C to Cass. Each entire part is published at 12s. 6d.

THE OXFORD BIBLE FOR TEACHERS. (London: Henry Frowde, Oxford University Press.)

These valuable Bibles and helps for teachers are issued in several sizes, and at a great variety of prices from 3s. upwards. The one before us is Ruby 16mo, No. 5a, on thin paper. The type is remarkably clear and distinct. The Helps to the Study of the Bible occupy 472 pages, and will prove most valuable to the teacher or Bible-student.

JOHNSTON'S PICTORIAL ASTRONOMICAL and Geographical Diagrams. Size, 50×42 inches. Price, 12s. on cloth and roller, varnished. (Edinburgh and London: W. and A. K. Johnston.)

This large wall-map contains a number of Astronomical Diagrams, showing Orbits of the Earth and Superior Planets; Day and Night, with the Moon's Orbit; Eclipses of the Sun and Moon; the Tides, Seasons, etc.; several Geographical Diagrams, showing Parallels of Latitude, Meridians of Longitude, Zones of the Earth, and Magnetic Compass; a large coloured view representing Natural Phenomena over the Globe, as well as man's work on it, such as Railways, Bridges, Cities, Harbours, Ships, etc.; and a map representing and explaining Geographical terms as indicated on maps. The Sheet is accompanied by an explanatory Handbook.

THE COMPREHENSIVE TEACHERS' BIBLE, together with New and Revised Helps to Bible Study, a New Concordance, and an Indexed Bible Atlas. (London: S. Bagster and Sons.)

We have received specimen copies of the Comprehensive Teachers' Bible,

and find the Helps contain a large amount of very valuable information, as, *e.g.*, Chapters on the Historical Origin of the Bible, Revelation, and Inspiration; Ancient and Modern Versions of the Old and New Testaments; National History of Israel; Jewish History between Old and New Testament periods; Natural History of the Bible; Chronological Tables; Index of Proper Names; Alphabetical Index to the Scriptures; a Concordance; and 14 coloured maps. These Bibles are handsomely bound, and prices vary from 4s. to 28s. 6d. The type of the Emerald 8vo (size $8\frac{1}{4}$ in. × $5\frac{3}{8}$ in. × $1\frac{3}{8}$ in. thick) is beautifully clear and distinct.

THE DIFFICULTIES OF ALGEBRA MADE EASY: A Book for Beginners. By H. C. Tarn. Post 8vo, pp. vii.-91. (London: Moffatt and Paige. 1883.) Price 1s.

This is an excellent little work, dealing chiefly with "Results of Multiplication" and "Resolution of Factors"—most important steps in Algebra, so seldom intelligently taught in our schools. The explanations and the graduated examples accompanying them are so good that we strongly recommend the book to all who have failed to grasp the "first principles" of Algebra.

MATTHEWS' EUCLID EXAMINATION PAPERS. Crown 8vo, pp. 191. (London: Moffat and Paige.) Price 1s.

These papers contain 400 Exercises on Euclid I.—IV., taken from the Cambridge Mathematical Tripos, London Matriculation, Queen's Scholarship, and Certificate Examinations, the whole forming an Appendix to Matthews' "Deductions from Euclid and how to work them." The "hints" for solution of problems, etc., are very useful.

MENSURATION MADE EASY, or the Decimal System for the Million, with its application to the daily employments of the Artizan and Mechanic. Eighteenth edition. Post 8vo, pp. 84. (London: Effingham, Wilson, and Co.) Price 1s.

This is specially written for those who have had deficient instruction in decimal arithmetic and calculations of Simple Measurements. It will be found to answer its purpose, but the most valuable pages are those on the decimal system of coinage, weights, and measures.

AN ELEMENTARY TREATISE ON MENSURATION, containing numerous Solutions and Examples. By E. J. Henchie. Crown 8vo, pp. xii.-224. (London: School Book Publishing Co., Red Lion Square.) Price 3s.

This supplies a long-felt want for a comprehensive work on Mensuration at a moderate price, and although it is called "elementary," a great variety of methods for the measurement of simple and complex figures are given. There are separate chapters on Land-surveying and Guaging. The examples are numerous and well arranged. Diagrams are freely introduced, and all references to Trigonometry avoided.

THE BOOK OF BEE-KEEPING: A Practical and Complete Manual on the Proper Management of Bees. By W. B. Webster. Crown 8vo, pp. 103. (London: L. Upcott Gill. 1888.)

A book which will doubtless prove very serviceable to the bee-keeper. After treating of the Advantages of Bee-keeping, the Natural History of the Honey Bee is somewhat fully dwelt on, more especially in describing the different varieties of Bees, followed by chapters on the Products of Bees, Appliances, Food, Swarming, Diseases, and Enemies of Bees, etc. There are several illustrations showing Cells and various kinds of frame and other hives.

Bicycles and Tricycles of the Year 1888. By Harry Hewitt Griffin. Crown 8vo, pp. 108. (London: L. Upcott Gill. 1888.) Price 1s.

A chronicle of the new Inventions and Improvements introduced each season, and a permanent record of the progress in the manufacture of Bicycles and Tricycles; designed also to assist intending purchasers in the choice of a machine. This book is in the eleventh year of its publication and has a number of illustrations.

The Mechanic's Workshop Handy Book: A Practical Manual on Mechanical Manipulation. By Paul N. Hasluck, A.I.M.E. Crown 8vo, pp. 136. (London: Crossby, Lockwood, and Son. 1888.) Price 2s.

Being designed for the help and guidance of young mechanics and others interested in the manipulation of metals, the little book commences with some account of the constituents and characteristics of Metals and Alloys familiar to the mechanic in his daily work. Special attention is given to the handling of various tools. Its chapters treat of Metals and Alloys, Iron, Steel, and Brass, and their Treatment; Tool Grinding, etc. It will doubtless prove useful to workers of all ages and degrees of experience.

Charles A. Gillig's Tours and Excursions in Great Britain: A day, week, or month on rail, road, and water. By Stephen F. Smart. Crown 8vo, pp. vii.-426. (London: The United States Exchange, 9 Strand.) Price 2s.

With the help of this book and an ample purse, the tourist may spend a month very pleasantly. He is supposed to start from London, and is conducted to a great number of places on the East Coast, round the South Coast, to Berwick-on-Tweed, and from thence to various places in Scotland, and finally on a series of Welsh tours.

A Year in the Fields. By John Watson. 12mo, pp. 118. (Edinburgh: David Douglass. 1888.) Price 1s.

In writing a history of the months, the author has preferred to describe them as they were at the time of writing (1886), and not according to preconceived notions, or "as they ought to be." This book reached us early in July, and we were surprised to find the present weather so accurately described. He says:—"We have now come to the close of the seventh month, and July has been as abnormal as the rest. Instead of the summer sun and glowing heat, we have been beaten and blown about by the blasts of October."

A Practical Treatise on the Manufacture of Cheap Non-Alcoholic Beverages, with Sketches of My Life as a Temperance Reformer. By Robert Seager, Ipswich. 12mo, pp. 96. (London: National Temperance Publication Depôt, 337 Strand.) Price 1s.

The writer gives a detailed account of the manufacture of a variety of temperance drinks for home use. He also assures us that the finest mineral water can be produced at the amazingly low cost of 1d. per dozen bottles, and that quart syphon bottles for table use may be filled at 1d. each.

The Handy Route-Book of England and Wales. Part II., Middle England, with Map. By Charles Howard. 12mo, pp. xvi.—309. (London: Mason and Payne. 1888.) Price 2s.

A very convenient work for the tourist, and especially so for the cyclist.

It gives the names of all Towns and Villages and places of interest passed on the road, with their distances from each other, and from the starting point as well as from the destination, the direction and distance of the nearest place on all the branch roads; a tariff of Hotel Charges, Railway Rates for Cycles, etc.

ILLUSTRATED GUIDE TO ILFRACOMBE AND NORTH DEVON. Edited by W. Walters. With Plans and Maps. Square 16mo, pp. x.—205. (Ilfracombe: Twiss and Son.) Price 1s.

The visitor to Ilfracombe and North Devon will find this a useful handbook. The topography has, we are told, been brought up to date of publication. A good description is given of all the places of interest in the neighbourhood. There are about 30 illustrations.

THE HOUSEHOLD HANDY BOOK: A Useful Manual for Everyday Life. Compiled by Mrs. Valentine. Crown 8vo, pp. xi.—308. (London: Frederick Warne and Co.) Price 2s. 6d.

Mrs. Valentine's book is addressed to young women, and is intended to give them information that may enable them to add a fresh amount of pleasure and usefulness to their lives. Advice and instruction on a great variety of subjects are given, ranging from Receipts for making Home Pretty; Fancy Work; Dress; Food and How to Cook it; Domestic Pets; to Geography, Arithmetic, and Natural Science.

CHOICE BRITISH FERNS: Their Varieties and Culture. By Charles T. Druery, F.L.S. With Illustrations of about 120 Select Ferns. Crown 8vo, pp. iv.—167. (London: L. Upcott Gill. 1888.)

A number of the most beautiful and striking forms of British Ferns are described and illustrated in a very pleasing manner, the plates being printed with a black ground on drab paper. The book is not overcrowded with scientific terms, and the common forms are described and figured so as to be easily recognised. The book is divided into two sections:—1.—The Collection and Cultivation of British Ferns; and 2.—The Fern Families of Britain.

MODERN ENGINE-MAKING in Theory and Practice. By J. Pocock. Cr. 8vo, pp. vi.—178. (London: Swan Sonnenschein and Co. 1888.) Price 2s. 6d.

A series of papers, which will doubtless prove useful to a large body of amateurs. Instructions are given for building model engines of all kinds and patterns. There are 115 engravings.

A TEXT-BOOK OF PHYSIOLOGY. By John Gray M'Kendrick, M.D., LL.D., F.R.S., etc. Including HISTOLOGY, by Philipp Stohr, M.D. 8vo, pp. xxv.—516. (Glasgow: James Maclehose & Sons. 1888.) Price 16s.

This will be found an exhaustive treatise on the general physiology of the tissues. The introductory section deals with general notions as to living matter, more especially with reference to the doctrines regarding energy which form the basis of modern science. The nature and properties of the chemical substances found in the bodies, and the nature of the chemical reactions with which the phenomena of life are associated, are then discussed. Then follows chapters on the physiology of the tissues, in which their origin is discussed in the light of recent investigations, and finally a section on the contractile tissues. This volume will be shortly followed by another on the special physiology of the organs. The work is illustrated with 318 engravings and a coloured plate of the spectra.

THE BEGINNINGS IN PHARMACY: An Introductory Treatise on the Practical Manipulation of Drugs, and the Various Processes employed in the Preparation of Medicines. By R. Rother. Second edition. 8vo, pp. vii.—342. (Detroit, Mich., U.S.A.: Wm. Graham Printing Co. 1888.)

This book cannot fail to be very useful to the student in pharmacy. The routine, as here presented, commences with the simpler object-lessons in the calling, and gradually becomes more and more difficult, but correspondingly important as the treatment progresses. We have been much pleased with the perusal of the book.

CURIOUS CREATURES AND THEIR WAYS, with Illustrations. By Marianne Bell. Crown 8vo, pp. 266. (London: St. Anselm's Society, 5 Agar Street. 1888.)

A series of entertaining papers, nicely illustrated, on Ancient Dragons; Seals and Sea-Lions; Mermaids and Sea-Cows; The Warriors of the Sea; Otters, Wild and Tame; Beavers and their Dwellings; Frogs and Toads; Rats and their Devices; Monkeys and their Faculties, etc. etc.

GEORGE BIRKBECK, the Pioneer of Popular Education: A Memoir and a Review. By John George Godard. Second edition. Crown 8vo, pp. xvi.—248. (London: Bemrose and Sons. 1888.) Price 2s. 6d.

In preparing the work before us, the author tells us he has consulted some 300 volumes. He narrates the Ancestry, Birth, and Early Life of Dr. Birkbeck; his early educational labours; formation of the London Mechanics' Institution; the Rapid Growth of the Popular Education Movement, etc. A portrait of the doctor forms a pleasing frontispiece to the volume.

FLOWER-GARDENING FOR AMATEURS in Town, Suburban, and Country Gardens, with a Chapter on the Greenhouse. By Lewis Castle. Crown 8vo, pp. xii.—236. (London: Swan Sonnenschein and Co. 1888.) Price 2s. 6d.

The object of this treatise is to furnish amateurs with a few hints upon subjects that are dealt with exhaustively in more elaborate works. It points out methods of diversifying the charms of a garden, as well as indicating the practical details of cultivation. It is nicely illustrated.

BRITISH REPTILES AND BATRACHIANS. By Catherine C. Hopley. Crown 8vo, pp. 94. (London: Swan Sonnenschein and Co. 1888.) Price 1s.

Another of the "Young Collector Series"—a series of books we strongly recommend all our young friends to become possessors of. This volume treats of the Viper, the Ring Snake, the Smooth Snake, Frogs, Toads, Newts, Lizards, etc.

INDIGESTION: Its Causes and Cure. By John H. Clarke, M.D. 12mo, pp. viii.—100. (London: James Epps and Co. 1888.) Price 1s.

In these pages the author first treats of the normal process of digestion, and then goes on to sketch the various deviations from the normal to which the process is liable, and to show how they may be avoided and how cured.

IRISH MINSTRELSY, being a Selection of Irish Songs, Lyrics, and Ballads, Original and Translated. Edited, with Notes and Introduction,

by H. Halliday Sparling. 16mo, pp. xviii.—368. (London: Walter Scott. 1887.)

A volume of the "Canterbury Poets" series, in which the attempt has been made of furnishing readers with an opportunity of judging Irish character, and of providing Irish readers with a book that, in its scope and completeness, might find a place on their own bookshelves.

THE POCKET GAZETTEER OF THE WORLD: A Dictionary of General Geography. Edited by J. G. Bartholomew, F.R.S.E., F.R.G.S., etc. 32mo, pp. ix.—630. (London: John Walker and Co., Warwick Lane. 1888.) Price 3s. 6d.

Here we have, in a small compass, a concise geographical description of 35,000 places, covering every place of importance in the world. In addition, there are nine maps, showing Height of Land and Depth of Sea; Zones of Temperature; Mean Annual Rainfall; Ocean Currents; Land Surface Features; Prevailing Winds; Density of Population; Races of Mankind; The British Empire; and Principal Routes of Commerce.

THE WORKS OF HUBERT HOWE BANCROFT: Vol. II., Native Races, Vol. II., 8vo, pp. xii.—805. (London: Trubner and Co. San Francisco: The History Publishing Co. 1886.)

Another of these important works is now before us. It continues the history of the Aborigines of the Pacific States, and describes in very readable language the more advanced Nuhua and Maya races, including their government, laws, courts of justice, land tenure, system of taxation, commerce, education, arts, and literature. We have been much interested with Chapter III., describing the Government of the Nahua nations, the magnificence of their Monarchs, the Ceremony of Anointment, Address of the High Priest to the King, Homage of the Nobles, General Rejoicing throughout the Kingdom, Ceremony of Coronation, with a description of the Crown, the Coronation Speech of one of the Kings, etc. etc. The volume contains a map and several good engravings, two representing Calendars of the Aztec Year and the Aztec month, the year being divided into months, containing 20 days; each month and day is represented by its peculiar hieroglyphic; these are specially interesting.

THE PHOTOGRAPHIC COLOURIST'S GUIDE. By John L. Gihon. Post 8vo, pp. 88. (New York: Edward L. Wilson. 1878.)

In the little work before us the author gives information with regard to all classes of photographs. Its twelve chapters treat of India-ink work, the Principles to be considered in the application of Colours, the production of the picture originally known as Ivorytype, Crayon work, etc.

HINTS FOR YACHT-BUILDING for Amateurs. By Tyrrell E. Biddle. 8vo, pp. 43. (London: George Wilson, 20 Glasshouse Street, Piccadilly, and Simpkin and Marshall. 1888.) Price 2s.

These "Hints" form a continuation of Mr. Biddle's Hints to Beginners in Amateur Yacht Designing, and contain full instructions with drawings for Building a Yacht.

THE NATURE AND CONSTITUTION OF THE EGO. By Anna Bonus Kingsford, M.D. Foolscap 4to. (London: Field and Tuer. 1888.) Price 1s.

A selection, being Lecture V., from "The Perfect Way."

BRITAIN'S SALAMIS, or the Glorious Fight of 1588. By W. H. K. Wright, F.R.Hist.Soc. With an Introductory Poem by Lewis Morris and other original poems and ballads. Foolscap 4to, pp. 71. (Plymouth: W. Frank Westcott. 1888.) Price 1s.

An Historical Lecture delivered at various places in the West of England by Mr. W. H. K. Wright.

WARRIOR KINGS from Charlemagne to Frederic the Great. By Lady Lamb. 8vo, pp. 378. (London: George Routledge and Sons. 1889.) Price 6s.

This handsomely bound book would be considered a very valuable present by many boys of our acquaintance. Its subjects are Charlemagne, William the Conqueror, Frederic Barbarossa, Richard Cœur de Lion, Edward I., Robert Bruce, Henry V., Frances I., Henry IV., Gustavus Adolphus, King of Sweden, Charles XII. of Sweden, and Frederic the Great. It contains a number of illustrations and twelve full-sized plates.

THE PHOTOGRAPHIC INSTRUCTOR for the Professional and Amateur, being the comprehensive series of practical lessons issued to the students of the Chautauqua School of Photography, revised and enlarged, edited by W. I. Lincoln Adams, editor of the *Photographic Times*. With an Appendix on the Nature and Uses of the various chemicals and substances employed in Photographic Practice, by Professor Charles Ehrmann. 8vo, pp. 196. (New York: Scoville Manufacturing Co. 1888.)

Two years ago the authorities of the Chautauqua University recognised the growing demand for photographic knowledge by establishing a school of photography with Chautauqua ideas, and as an integral part of the great university; of this school Professor Ehrmann was chosen instructor. The introduction tells us that "the series of lessons which follow this are written more especially for those who know little or nothing of the charming art of photography, yet who desire to be taught its mysteries by easy, simple methods, leaving for later study the whys and the wherefores, the chemistry of the science."

We have gone carefully through the book and find that the subject has been well treated. The book, like all the rest of the Scoville Co.'s publications, is beautifully got up and well illustrated with wood engravings in the text, in addition to which the frontispiece is a half-tone engraving direct from the negative of a view at Chautauqua. There is also a photo of the Professor in his studies.

THE PHOTOGRAPHIC NEGATIVE, written as a Practical Guide to the preparation of sensitive surfaces by the Calotype, Albumen, Collodion, and Gelatine processes on glass and paper, with supplementary chapters on development, etc. By the Rev. W. H. Burbank. 8vo, pp. 198. (New York: Scoville Manufacturing Co. 1888.)

The author is so well known in the photographic world that we are sure to find instruction in whatever emanates from his pen. He tells us that he has aimed to select only those methods known to have permanent value, and in addition to those subjects mentioned in the title, as quoted above, the volume treats of Methods of Stripping Films from Glass Plates, Colour-sensitive Plates, Instantaneous Photography, Photo-Micrography, and Micro-Photography, the Transformation of Negatives to Positives, etc. The book is well illustrated.

T' Fisher Folk of Filey Bay: Poems chiefly in the Yorkshire dialect. By the Rev. W. H. Oxley, M.A. 4to, pp. 46. (Scarborough: E. T. W. Dennis. 1888.)

A collection of interesting Poems, illustrated with etchings describing "Our Parson," "The Widow's Tale," "T' Sunrise fre' t' Window, ov t' Auld Cottage on t' Cliff Top," etc.

The Chess-Player's Manual, containing the Laws of the Game, according to the revised code laid down by the British Chess Association, 1862, by G. H. D. Gossip, revised and edited with an American Appendix by S. Lipschütz. 8vo, pp. xi.-884. Appendix, pp. v.-122. (London: George Routledge and Sons. 1888.)

This work contains comprehensive and thorough analysis of all the openings—both regular and irregular—with the most important discoveries that have been made of late years by the leading authorities. The Appendix contains Revisions, Amendments, Specimen Games, and a number of Problems selected from recent first-prize compositions, thus bringing the entire work fully up to date. It is a handsomely got up volume and well illustrated with diagrams.

Modern Science in Bible Lands. By Sir J. William Dawson, C.M.G., LL.D., F.R.S., F.G.S., etc., with Maps and Illustrations. Crown 8vo, pp. xii.-606. (London: Hodder and Stoughton. 1888.) Price 9s.

The author of this exceedingly interesting book desires his readers to share with him the pleasure of a tour in Italy, Egypt, and Syria, in which he studied such points in the geology and physical features of those countries as might throw light on their ancient history, and especially on the history of the Scriptures. The chapters treat of the Firebelt of Southern Europe, the Haunts and Habits of Primitive Man, Early Man in Genesis, Egyptian Stones and Teaching, Egypt and Israel, The Topography of the Exodus, Palestine—its Structure and History, Resources and Prospects of Bible Lands, etc. There are numerous illustrations.

The Thermal Baths of Bath: Their History, Literature, Medical and Surgical Uses and Effects, together with the Aix-Massage and Natural Vapour Treatment. By Henry William Freeman, F.R.C.S.I., M.R.C.S., L.C.P., etc. Crown 8vo, pp. xliv.—379. (London: Hamilton, Adams, and Co. Bath: Charles Hallett. 1888.) Price 5s.

Dr. Freeman gives, in the work before us, a capital history of these world-famed baths, which, we feel sure, will be read with interest by many who do not require the waters for their medicinal values. A sketch of the lives of some of the most prominent Bath physicians of a former age is given, with a list of their more important works. In the account of the springs, comparisons, both quantitatively and qualitatively, are made with Continental and other Foreign Spas. The subject of Massage is treated at considerable length, the European and American systems being respectively described. We notice also that the diseases in which the Waters are, and those in which they are not found efficacious, are carefully described and classified. The book is beautifully illustrated by a number of Woodburytype plates and large folding maps of the ancient Roman, and modern baths.

Nature and the Bible: Illustrations of the Philosophy of Universal Motion. Second edition, with an Appendix showing the Causes of

Earthquakes, Volcanic Eruptions, and Shooting Stars. By James Davis, C.E. 12mo, pp. xi.—246 + 36. (London: Houlston and Sons. 1887.) Price 5s.

This little book is divided into two sections, the first being entitled the Laws of Motion as defined in Mathematics, being the Philosophy of Time; and the second, the Philosophy of Motion applied to Universal Creation in agreement with the Sacred Scriptures. There is also an Appendix on Evidences Natural and Revealed concerning Earthquakes, Volcanic Eruptions, and Meteors and Shooting Stars.

Kindergarten Education. By M. Stephens. Post 8vo, pp. vii.—63. (Dublin: Alex. Thom and Co. 1888.) Price 2s. 6d.

By the aid of this little book parents will have no difficulty in carrying on the system of kindergarten education with their young children. The book is really addressed to teachers and the whole system is thoroughly explained. At the end are 26 well-engraved plates, showing the manner of using the blocks, etc.

A Manual of the English Language. By John Gibson, M.A. Crown 8vo, pp. 88. (London: Cornish and Sons. 1888.)

Mr. Gibson's "Manuals and Guides" are well known. This one is quite up to their usual standard of usefulness as a careful epitome of larger Grammars. The Appendix contains test papers for Examination students.

Amateur Work. (London: Ward and Lock.) Price 6d.

The September part of this well-known publication contains, among other things, a full-sized drawing of designs for an Occasional Chair, with Fret-work Ornamentation, and a great variety of information specially valuable to the amateur. The articles are well illustrated.

Our Earth and Its Story. Edited by Dr. Robert Brown, M.A., F.R.G.S., F.L.S., etc. (London: Cassell & Co.) Price 6d. monthly.

Part 20 of this interesting work has reached us, and contains an account of the Cainozoic Deposits; the Pleistocene System; the Quaternary Period; and Prehistoric Man and his Dwelling-Places. It contains a coloured map, showing the Distribution of Vegetation and a number of excellent wood engravings.

The World's Inhabitants; or, Mankind, Animals, and Plants. By G. T. Bettany, M.A., B.Sc. London: Ward and Lock.) Price 6d. monthly.

We have before us the eleventh part of this work, in which are described the Inhabitants of South Africa, the South Tropical Africans, the Malagasy, the Distribution of the African Races, African Animals, and African Plants. The illustrations are numerous and good.

The Prescription, Therapeutically, Pharmaceutically, and Grammatically Considered. By Otta A. Wall, M.D., Ph.G., etc. 8vo, pp. 184. (St. Louis, Mo., U.S.A.: The Aug. Gast Bank Note Co. 1888.)

This work is intended for the use of American students, but there is much in it likely to interest those engaged in medicine and pharmacy. The teaching throughout is of a high order, and the different subjects are dealt with in a conscientious manner.

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